UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART XVI.

REPORT

OF

THE COMMISSIONER

FOR

1888.

[JULY 1, 1888, TO JUNE 30, 1889.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1892.

Resolved by the House of Representatives (*the Senate concurring*), That the Report of the Commissioner of Fish and Fisheries for the year 1888 be printed; and that there be printed 11,000 extra copies, of which 3,000 copies shall be for the use of the Senate, 6,000 for the use of the House of Representatives, and 2,000 for the use of the Commissioner of Fish and Fisheries. The illustrations to be obtained by the Public Printer, under the direction of the Joint Committee on Printing.

Agreed to by the Senate August 13, 1890.

Agreed to by the House August 27, 1890.

CONTENTS.

APPENDICES.

LIST OF ILLUSTRATIONS.

FISHERIES OF THE PACIFIC COAST OF THE UNITED STATES.

FISHERIES OF THE PACIFIC COAST OF THE UNITED STATES—Continued.

INVESTIGATIONS OF THE ALBATROSS.

NOTES ON ENTOZOA OF MARINE FISHES, WITH DESCRIPTIONS OF NEW SPECIES.

ON THE ANATOMY OF THYSANOCEPHALUM CRISPUM LINTON, A PARASITE OF THE TIGER SHARK.

A REVIEW OF THE CENTRARCHIDÆ.

THE APODAL FISHES OR EELS OF NORTH AMERICA AND EUROPE.

THE CHEMICAL COMPOSITION OF FOOD-FISHES.

THE CENTENNIAL EXPOSITION AT CINCINNATI.

REPORT

OF THE

UNITED STATES COMMISSIONER OF FISH AND FISHERIES

FOR THE

FISCAL YEAR ENDING JUNE 30, 1889.

The constitution of the Fish Commission as a separate bureau of the Government, which was accomplished by act of Congress approved January 20, 1888, terminated those relations of coöperation which had been so happily maintained with the Smithsonian Institution and National Museum under the wise and liberal administration of Prof. S. F. Baird—a coöperation which enlisted the aid of scientific workers in the solution of important economic problems, and also stimulated and encouraged research by presenting specific and important practical questions for investigation.

Another important and fruitful result of this coöperation was the acquisition (during investigations relating to the fishing-grounds and the distribution and abundance of the economic species of fishes) of rich stores of specimens of the strange and curious life of the ocean's depths. These collections are of the utmost value for systematic study and for the enrichment of museums.

The abrupt termination of relations so long subsisting was not without serious embarrassments and inconveniences, requiring new adjustments and arrangements, which it has been the care of the Commissioner to provide as rapidly as circumstances and means would permit.

The offices of the Commission, which had been previously scattered in different parts of the city, were as far as practicable brought together in one building, thus permitting better supervision and more prompt communication, and resulting in more convenient and economical administration of affairs. The want of adequate accommodations for the offices of the Commission having been brought to the attention of Congress, provision was made in the sundry civil bill, which became a law March 2, 1889, for an appropriation of $7,000 for altering and fitting up

the interior of the Armory building then and now occupied as a hatching station of the Commission. The appropriation was made immediately available, to be expended under the direction of the Architect of the Capitol. Having advised with the Commissioner as to the work to be undertaken, Mr. Clark immediately began operations, and at the close of the fiscal year all was complete and ready for occupation.

A portion of the building was by the act referred to reserved for the use of the Smithsonian Institution, and the accommodations afforded the Commission are not adequate to its necessities; it is therefore desirable that the entire building should be assigned to the use of the Fish Commission as soon as practicable.

OFFICE ADMINISTRATION.

The large number of stations of the Commission, its vessels, and the great increase in the distribution of food-fishes over the country, have involved an enormous mass of correspondence and other details of administration. In these duties the Commissioner has had the faithful and efficient services of Mr. J. J. O'Connor, chief clerk, and Mr. Herbert A. Gill, disbursing agent, in charge of the office of accounts.

The appropriations for the fiscal year ending June 30, 1889, aggregated $257,580, as follows:

Compensation of Commissioner	$5,000
Propagation of food-fishes	135,000
Rent of offices	2,500
Distribution of food-fishes	31,180
Maintenance of vessels	53,900
Inquiry respecting food-fishes	20,000
Statistical inquiry	10,000

In accordance with law a detailed report of expenditures under these several items of appropriation was made to Congress on December 9, 1889.

CLASSIFICATION OF THE COMMISSION'S WORK.

The classification and assignment of the work of the Commission to the several divisions which had been established or projected by my immediate predecessor in office, Dr. G. Brown Goode, has proved of great advantage. While maintaining independent responsibility in the heads of divisions it has made practicable a coördination and concurrence of activity in reference to the problems relating to the fisheries and has prevented any unnecessary duplication of work.

The following brief account of the current work in the divisions will illustrate very clearly the extent, importance, and diversity of the operations of the Fish Commission and its value to the country at large.

INQUIRY RESPECTING FOOD-FISHES AND THE FISHING-GROUNDS.

The investigation of the character and resources of the fishing-grounds, and of the conditions controlling the distribution of fishes and other aquatic animals, together with the ascertainment of the life-history of commercially important species, furnishes the only correct basis for the regulation and improvement of our fisheries, for the instruction of the fisherman as to the best and most profitable methods of pursuing his calling, and for the successful conduct of fish-cultural operations.

In the early period of the Commission the inquiries pursued were necessarily general in character. A survey of the immense field to be exploited was first necessary to suggest or to give precise direction to those more particular inquiries upon which we are now entering, and which are intimately and essentially related to various important problems affecting the fisheries.

The following brief review will illustrate the activity and energy displayed in the division of the Commission having charge of the inquiry in regard to the fishing-grounds, as well as the significance and practical importance of the subjects investigated. Fuller details will be found in the very interesting and instructive report of the assistant in charge of the division, Mr. Richard Rathbun, which is appended to and forms a part of this report.

The most important sea-coast inquiries conducted during the year have been the investigations in the North Pacific Ocean by the steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. The *Albatross* reached San Francisco from the Atlantic coast in May, 1888, and, after a month and a half spent in preparations for the cruise, left July 4 for Alaskan waters, where a running survey was made of the fishing-grounds situated south of the Alaska Peninsula between Unalaska and Middleton Island. The area covered by these explorations comprised the entire width of the continental platform, extending into depths of 100 to 200 fathoms, and including five principal cod-fishing banks, having a total area of over 15,000 square miles. The intervening ground, moreover, is in most places adapted to fishing and the adjacent shores are well provided with good and secure harbors. Although cod fishing has been carried on in this region to a limited extent during the past twenty-five or thirty years, no systematic inquiry had been made to determine the distribution and value of its resources prior to the visit of the *Albatross*. The result of these researches can not fail, therefore, to have an important influence on the development of this territory.

After returning from Alaska, in September, the *Albatross* began a similar investigation along the coasts of Washington and Oregon, which was continued during October, 1888, and again in June, 1889. During the winter and early part of the spring, the work was extended

to the coast of southern California, between Point Conception and the Mexican boundary line, and to the Gulf of California. In the course of these inquiries important results were accomplished and several new fishing-grounds were brought to the attention of the fishermen. The most important discoveries in this line had reference to Cortez and Tanner banks, directly off San Diego. Heceta Bank, off the coast of Oregon, and the halibut banks off Cape Flattery were also examined and the character and value of their resources partly determined. The observations made in the Gulf of California, together with an investigation of the Colorado River and its principal tributaries at about the same time, tend to prove that this river system is not suited to the introduction of the Atlantic shad, which has done so well farther north on the Pacific coast, and no traces were discovered of the few plantings made in this region several years ago. The problem of oyster-culture on the coast of California received attention from the naturalists of the *Albatross*, and the vessel also rendered assistance in distributing the live lobsters sent over from New England and placed in those waters.

On the Atlantic coast, instead of continuing the general explorations which had been carried on for several years, the steamer *Fish Hawk* was assigned to special investigations, having reference chiefly to the oyster-grounds of Long Island Sound and Rhode Island. No other fishing industry, probably, has greater claims at present upon the attention of the Fish Commission with respect to its maintenance and development than that afforded by the oyster. On the coast of New England and New York, some measures of protection are demanded against the drills and starfishes which destroy large quantities of oysters every year; in Chesapeake Bay the production has steadily been decreasing since 1880, and on the South Atlantic and Gulf coasts an active interest has recently been shown in devising means for improving and developing the wild growths of oysters which occur wherever favorable conditions now exist. Moreover, the natural supply of seed oysters is totally inadequate to meet the demands of planters and some economical methods of artificial cultivation are desirable in order to relieve this want.

In connection with all of these questions the several States have ooked to the U. S. Fish Commission for assistance, especially in the way of scientific investigation and experiments on which to base the necessary measures for relief. While not having sufficient means to press the inquiries in this direction as rapidly as seems desirable, arrangements have been made to give them every possible attention and to detail for this purpose the steamer *Fish Hawk* and such launches as may be necessary, when not required for fish-cultural and other more urgent work. The researches conducted by the *Fish Hawk* on the southern coast of New England during the season of 1888 are described in the special report of the assistant in charge of scientific inquiry. The grounds visited were carefully examined as to their conditions in every

particular, and observations were made upon the physical characteristics of the waters and upon the natural history of the oyster, its enemies and associates. It is proposed to continue the investigations in the same field during the summer of 1889.

During the winter of 1888–89 extensive operations were conducted in the Gulf of Mexico by the schooner *Grampus* and the steamer *Fish Hawk*. The former vessel was detailed to examine the southern part of the important red-snapper fishing-ground which occupies the submerged continental platform off the west coast of Florida. The inshore or shallow-water part of this ground is now visited to a greater or less extent by fishermen, and the work of the *Grampus* was restricted to depths between 15 and 50 fathoms, in which the conditions and resources of the bottom were comparatively unknown. Notwithstanding the fact that much stormy weather was encountered, important results were obtained and the attention of the fishermen has been called to the advantages offered by this region for the prosecution of their industry. In addition to the fishing carried on, the dredge was used at frequent and regular intervals to determine the composition of the bottom and the characteristic animals which live upon it. In conjunction with the *Grampus* Dr. James A. Henshall made an examination of the adjacent coast of Florida from Biscayne Bay to Tampa, during which he obtained a very large collection of fishes and secured much information regarding the abundance, distribution, and habits of the more important species.

The principal work done by the *Fish Hawk* in the Gulf of Mexico had reference to the breeding habits of the mullet, sheepshead, and squeteague in Charlotte Harbor and vicinity, on the west coast of Florida, and the measures necessary to be taken for the artificial propagation of those species. Spawn of the two species last mentioned was obtained and hatched successfully, but when the *Fish Hawk* reached this locality it proved to be too late for the spawning of the mullet, although the young were observed in great numbers and their habits were, to some extent, determined.

An essentially novel feature of the scientific work, introduced during the past year, has been the systematic investigation of interior waters, with respect both to their physical and natural-history characteristics. This subject was taken up with the object of obtaining more accurate and extensive information in that direction, as a basis for fish-cultural operations and the distribution of useful fishes; for, until the conditions and principal features of any stream or lake have been determined it is impossible to say whether they require attention, and, if so, what measures should be taken to multiply their resources or perfect the quality of the latter. With respect to this subject, it is necessary to ascertain not only what kinds of fishes inhabit each fresh-water system, but also the abundance and distribution of the lower forms of life serving them as food and those physical conditions which, regulating their habits, determine what new species may be adapted to the region.

In carrying on this series of investigations it has been necessary, owing to the lack of sufficient funds, to rely chiefly on the services of volunteer naturalists, and most assistance in this direction has been furnished by Dr. David S. Jordan, president of the Indiana University, and his associate professors and students in ichthyology. Special mention should be made in this connection of Prof. Charles H. Gilbert, Prof. B. W. Evermann, and Mr. C. H. Bollman. Dr. James A. Henshall, of Cincinnati, Ohio, also volunteered his services during the summer of 1888. After a conference with Dr. Jordan as to the observations which it was desirable should be made, the work was mostly placed under his immediate direction, and the part intrusted to him has been conducted in a very zealous and appreciative manner. The investigations made up to the close of the year had reference to seventeen States, as follows: New York, Virginia, West Virginia, North Carolina, South Carolina, Tennessee, Kentucky, Georgia, Alabama, Mississippi, Louisiana, Ohio, Indiana, Michigan, Iowa, Missouri, and Arkansas.

During the winter of 1888–89 Congress passed an act to provide for the protection of the salmon fisheries of Alaska, which, owing to the rapid increase in the number of salmon canneries established in certain parts of that Territory and the wholesale methods of capture resorted to, seemed in great danger of being seriously depleted within a comparatively few years unless subjected to appropriate regulations. By this enactment it was declared unlawful to erect dams, barricades, or other obstructions in any of the rivers of Alaska, which might prevent or impede the ascent of salmon and other anadromous fishes to their spawning-grounds, and, furthermore, the Commissioner of Fisheries was directed "to institute an investigation into the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions and methods of the fisheries, with a view of recommending to Congress such additional legislation as may be necessary to prevent the impairment or exhaustion of these valuable fisheries, and placing them under regular and permanent conditions of production."

In accordance with this provision, arrangements were made for undertaking the investigation directed during the summer of 1889, and a party suitably equipped for that purpose was organized in June. It set sail for Alaska early in July, immediately after the close of the fiscal year. The party was in charge of Dr. Tarleton H. Bean, ichthyologist of the Commission, and personally acquainted with Alaskan waters, and consisted besides himself of Mr. Livingston Stone, superintendent of the Fish Commission salmon station in California; Mr. Franklin Booth, engineer, of the University of California; and Mr. Robert E. Lewis, general assistant. They have been directed to first visit Kadiak and Afognak islands, the principal centers of the canning interests in Alaska, and subsequently, if the time permits, Cook Inlet and Bristol Bay. Their instructions comprehend a very thorough investigation, and it is confidently expected that sufficient informa-

tion will be obtained to permit of a full understanding of the situation by the next Congress.

The daily observations of temperature along the sea-coasts and on the interior lakes and rivers, begun several years ago, have been continued during the past year at a number of the more exposed light-houses and at many stations of the Signal Service. The value of such observations will readily be appreciated by the student of geographical distribution, and a comparison of the results now in progress of compilation will undoubtedly throw much light on the movements of our migratory fishes.

The temperature data heretofore obtained serve only to show the temperature fluctuations in the waters immediately adjacent to the coast. The deductions from these have been sufficient to show that the movements of the fishes in the inshore waters, their appearance and departure, and their failure to appear in certain seasons in certain localities are to be attributed to differences of temperature conditions prevailing at different times. Observation and experience have suggested that the seasonal migrations and distribution in our coastal waters of many important economic fishes is to be explained and indeed to be predicted when we can obtain precise knowledge of the laws governing the seasonal changes of temperature in the area of water lying between our coast and the western border of the Gulf Stream. The migration of the areas of equal water temperature will be different in the different seasons and determine corresponding differences in the areas over which fishing may be profitably pursued.

It will, however, doubtless be found that the seasonal migrations of the areas of equal temperature in the sea will be in close and essential relations with the meteorological conditions on the land, which are under constant observation and discussion, and in time a knowledge of one will enable us to interpret the other, and thus indicate the probable distribution for the season of such species as the mackerel, the menhaden, the sea herring, and others which are pursued for their commercial value. Such information would relieve many perplexities and embarrassments which now discourage our fishermen, and give better direction to their enterprise and consequently better assurance of success in their endeavors. The investigations proposed and the discussion of the data obtained would doubtless lead to many important generalizations on the physical geography of the sea and the relations of marine species to their physical environments.

Being impressed with the importance of a systematic study of the temperature conditions and the changes of conditions in our offshore waters, I have instituted a systematic investigation to this end and have assigned the Fish Commission schooner *Grampus* to this work. Prof. William Libbey, of Princeton College, has been selected to take charge of the investigation, and the vessel is now being fitted with the necessary apparatus and appliances for the work, and will enter upon it at the beginning of the next fiscal year.

The scientific laboratory attached to the marine station at Wood's Holl, Mass., was opened as usual during the summer of 1888, the Commissioner being present during most of the time. The assistants engaged in Fish Commission work were employed only for the season, and in addition the facilities of the laboratory were granted to several biologists interested in the study of marine life. The persons in attendance were representatives of a number of the prominent scientific institutions of the country, and by their presence and coöperation they added very greatly to the value of the practical results obtained. The institutions thus represented were as follows: University of Pennsylvania, Harvard University, Johns Hopkins University, Princeton College, Williams College, University of Indiana, Swarthmore College, Wooster University, and the Lake Laboratory at Milwaukee, Wisconsin. Prof. John A. Ryder, of the University of Pennsylvania, a former assistant on the Fish Commission, was in direct charge of the scientific work.

The opportunities for research afforded by the Wood's Holl laboratory have been fully described in previous reports. Not only is the equipment well adapted to the study of marine problems of nearly every essential character, but the geographical position of the station with respect to a large assemblage of useful fishes gives it unusual advantages from the standpoint of the practical objects of the Commission.

The transfer of the steamer *Albatross* to the Pacific coast and the detail of the steamer *Fish Hawk* to the investigation of oyster-grounds have for the time removed the principal means of obtaining material from the offshore regions, and it has been necessary to restrict the researches chiefly to such inquiries as are offered by the immediate vicinity of the shores, but in this way the requirements of fish-culture have been more directly benefited, as the most important fisheries of the region are located within the bays and sounds or directly adjacent thereto.

The studies of Prof. Ryder have related chiefly to the life history of the sea bass and the Atlantic sturgeon, two important species, the artificial propagation of which may soon become expedient. The material bearing upon the sturgeon was obtained in Delaware Bay the previous spring, but the sea bass is one of the most highly prized fishes of the Vineyard Sound region, where it breeds during May and June. Mr. S. F. Denton, an experienced naturalist and artist, was employed in making colored drawings of the principal food-fishes indigenous to these waters, and Mr. C. F. Hodge was occupied with the natural history of the common starfish, the most serious and destructive enemy of the oyster on the New England coast. Other investigations have had reference to the cod, scup, tautog, mackerel, bonito, lobster, and soft clam. Summarizing the work accomplished, Prof. Ryder states that at least eight important monographic reports may be expected as the outcome wholly or in part of the investigations carried on at Wood's Holl during the season.

Mr. V. N. Edwards, who has been stationed permanently at Wood's Holl since 1871, has continued his observations upon the movements, habits, and abundance of the fishes of this region and has obtained large and valuable collections. A compilation of his results during the past eighteen years, which is now in progress, will prove a very valuable contribution to the natural history of our marine fishes.

The Commissioner is pleased to note the establishment at Wood's Holl of a marine biological laboratory intended for both students and investigators, which can not fail to have an important function in stimulating scientific research in this direction, and ultimately in promoting the interests of fish-culture by its contributions. This institution had its origin in Boston, and counts several well-known biologists among its instructors. The director is Prof. C. O. Whitman, of Clark University.

Prof. W. O. Atwater, of Wesleyan University, Middletown, Conn., who began for the Fish Commission, about ten years ago, a very comprehensive series of experiments upon the chemical composition and nutritive values of the American food-fishes, has completed his undertaking during the past year, and his report upon the subject is published in the appendix to this volume. Fifty-five species of fishes and eleven of mollusks and crustaceans were analyzed. The report is divided into two parts, the first being chiefly occupied with the technical details of analyses, while the second is more popular in character and explains the deductions reached by the author, together with their bearing upon different fishery problems. This important monograph can not fail to attract much attention from those interested in the fisheries, whether from a practical or scientific standpoint.

METHODS AND STATISTICS OF THE FISHERIES.

The work of this division relates to the history, methods, and statistics of the commercial fisheries; and the discussion and interpretation of the data obtained will, it is expected, contribute greatly to the advancement of these interests.

The appropriation for this branch of the service, $15,000, was small for the extent of territory to be covered, but it was used with economy, the expenses of the field agents having been especially low, the cost of travel and subsistence averaging only $3.86 per man daily. Investigations were carried on in Maine, Massachusetts, Rhode Island, New York, Pennsylvania, New Jersey, Delaware, Maryland, North Carolina, Florida, Alabama, Mississippi, Louisiana, Texas, the Great Lakes, the Pacific Coast, and Alaska. The statistics, methods, and relations of the fisheries of these regions were studied in detail, and with a view to the preparation of reports. Valuable information of a similar nature was obtained also through the medium of the statistical circulars of the Treasury Department, of which more than 10,000 were returned

to the Fish Commission in 1888 and 1889. Through local agents and bureaus, as well as by correspondence and the utilization of newspaper items, much additional knowledge of the fisheries was obtained.

Pending the negotiations looking toward a fishery treaty with Great Britain, the American commissioners were furnished with statistics, papers, maps, and personal explanations bearing upon the relations of the interested parties, and although the treaty was not ratified a *modus vivendi* was agreed upon for a period of two years.

The announcement to the fishery interests, through the investigations of the *Grampus* in the spring of 1888, of the scarcity of mackerel along the coast partly prepared the fleet for the unfavorable season which followed. Inasmuch as the history of this fishery shows many similar great fluctuations in the abundance of this species without adequate explanation, it may reasonably be expected that recourse to artificial hatching, the methods of which are now fully understood, will aid in reëstablishing this valuable fishery on a permanent basis.

The artificial freezing of fish recommended by this Commission as available for adoption by New England fishermen, was successfully and very profitably applied by Mr. William H. Jordan, of Gloucester, Mass., in the transportation of herring from Newfoundland.

Fuller details of the work of this division for the current year will be found in the report of the assistant in charge of the division, Capt. J. W. Collins, which is appended to and constitutes a part of this report.

FISH-CULTURE.

The work of this division has been under the immediate direction of the Commissioner, such duty being made necessary by his previous relations to and experience as assistant in charge of the division of fish-culture. With the continual expansion of the operations of the Commission and the increasing care and responsibilities incident to the general administration, it will not be practicable for the Commissioner to continue personal supervision of the fish-cultural operations longer than is necessary to establish satisfactory direction of the work under the superintendence of an assistant.

The work for the present season shows a gratifying improvement over the results of the previous year. This is indicated both by the large increase in the number of eggs and fry distributed, and by the greater number of yearling fish reared and distributed. The total effective production is shown by the following table:

Fish and eggs furnished for distribution by the stations for the year ending June 30, 1889.

Station.	Species.	Eggs.	Fry.	Yearlings.	Total.
Alpena, Mich	Whitefish	(*a*)	23,320,000		23,320,000
	Lake trout		80,000		80,000
Baird, Cal	California salmon	3,450,000	1,500,000		4,950,000
Battery Island, Md	Shad		41,543,000		41,543,000
Craig's Brook, Me	Landlocked salmon			5,984	5,984
	Atlantic salmon	1,395,000	19,000	13,961	1,427,961
Central, Washington, D. C.	German carp			190,928	190,928
	Goldfish			6,509	6,509
	Landlocked salmon		27,000		27,000
	Rainbow trout			10,280	10,280
	Brook trout		21,000	125	21,125
	Lake trout		36,000		36,000
	Whitefish		4,595,000		4,595,000
	Rock bass			1,218	1,218
	Tench			1,530	1,530
	Shad		34,501,000		34,501,000
Clackamas, Oregon	California salmon		4,500,000		4,500,000
Cold Spring Harbor, New York.	Landlocked salmon		20,000		20,000
	Atlantic salmon		638,000		638,000
	Lake trout		430,000		430,000
Duluth, Minn	Landlocked salmon		50,000		50,000
	Lake trout		985,000		985,000
	Whitefish		8,000,000		8,000,000
	Pike perch		3,000,000		3,000,000
Ft. Washington, Md	Shad	(*b*)	2,994,000		2,994,000
Gloucester, Mass	Codfish		11,011,000		11,011,000
	Pollock		7,258,000		7,258,000
Schoodic, Me	Landlocked salmon	*c* 350,000	205,000		555,000
	Atlantic salmon		198,000		198,000
Northville, Mich	Rainbow trout	*d* 55,000		49,264	104,264
	Brook trout	*e* 150,000		13,875	163,875
	Lake trout	*f* 655,000		28,525	683,525
	Loch Leven trout	120,000			120,000
	Whitefish	*g* 6,250,000	4,520,000		10,770,000
Sandusky, Ohio	Pike perch		47,190,000		47,190,000
	Whitefish	*h* 24,400,000	40,700,000		65,100,000
Steamer Fish Hawk	Shad		22,956,000		22,956,000
	Sheepshead		14,000,000		14,000,000
Wood's Holl, Mass	Codfish		8,137,000		8,137,000
	Lobsters		1,574,000	333	1,574,333
	Scup		30,000		30,000
	Sea bass		1,025,000		1,025,000
	Sole			28	28
	Mackerel		185,000		185,000
Wytheville, Va	Landlocked salmon		4,950		4,950
	Rainbow trout	109,500		39,308	148,808
	Brook trout			500	500
	Lake trout			575	575
	Rock bass			4,430	4,430
	Goldfish			3,101	3,101
	German carp			18,315	18,315
Quincy, Ill., collections from sloughs and lakes, caused by overflow of the Mississippi River.	Spotted catfish			20,180	20,180
	Buffalo			10,360	10,360
	Crappie			16,768	16,768
	White bass			15,552	15,552
	Black bass			17,687	17,687
	Sunfish			3,688	3,688
	Pickerel			7,811	7,811
	White perch			2,485	2,485
	Pike perch			5,600	5,600
	Native carp			460	460
(International exchange) from Berneuchen, Germany.	Brown trout	44,000			44,000
	Sälbling	9,000			9,000
(Int. exchange from Schmaldow, Germany.	Brown trout	66,000			66,000
	Total	37,053,500	285,252,950	489,380	322,795,830

a 5,000,000 transferred to Central Station; 5,000,000 to Duluth Station.
b 54,964,000 transferred to Central Station.
c 25,000 transferred to Craig's Brook Station; 25,000 to Cold Spring Harbor Station; 30,000 to Central Station; 50,000 to Duluth Station; 30,000 to Wytheville Station.
d 2,500 to Craig's Brook Station.
e 2,000 to Craig's Brook Station; 25,000 to Wytheville Station; 30,000 to Central Station.
f 1,000,000 to Duluth Station; 40,000 to Central Station; 500,000 to Cold Spring Harbor Station; 2,000 to Craig's Brook Station.
g 5,000,000 to Car No. 3.
h 9,000,000 to Duluth Station.

NOTE.—The "Summary of Distribution for the year ending June 30, 1889," p. 380, should be amended so that the total of eggs would be 37,053,500, and the grand total 322,795,830, credit having been taken for the foregoing transfers both as eggs and fry.

A comparison of this with a similar table contained in the report of the previous year shows a gratifying increase in the number of eggs and fry distributed. The most notable advance, since it promises such important results in stocking, was the increase in the number of yearling trout, salmon, and other native food-fishes distributed. The often inadequate and disappointing results from stocking with the fry of trout and salmon has led to this new departure, preparations for which were begun in 1886 by enlarging the trough capacity at several of the stations and by building rearing ponds and increasing the water supply. The number of yearling fish distributed in 1888 was 48,000, nearly all of which were the Eastern brook trout and the rainbow trout of the Pacific coast. The distribution the present year amounted to 274,000 fingerlings of the following species, artificially bred and reared, viz, Atlantic salmon, landlocked salmon, rainbow trout, brook trout, salmon or lake trout, carp, goldfish, tench.

The artificial propagation of the pike perch was undertaken by the Commission at the Sandusky and Duluth hatcheries. Fifty million fry were obtained, which were distributed to lakes and streams in Minnesota, Illinois, Ohio, New York, and Pennsylvania.

The following species, collected from the overflow ponds of the Mississippi Valley, were also distributed: Fresh-water drum, rock bass, crappie, black bass, white bass, pike perch, pickerel, buffalo, catfish. This branch of our work will be extended as rapidly as the requisite additional facilities can be provided.

During the year terminating June 30, 1888, fifteen stations, including Sandusky and Quincy, were in active operation:

1. Schoodic Station, Maine.
2. Craig's Brook Station, Maine.
3. Gloucester Station, Massachusetts.
4. Wood's Holl Station, Massachusetts.
5. Cold Spring Harbor Station, New York.
6. Battery Island Station, Maryland.
7. Fort Washington Station, Maryland.
8. Central Station, Washington, D. C.
9. Fish Ponds, Washington, D. C.
10. Wytheville Station, Virginia.
11. Sandusky Station, Ohio.
12. Quincy Station, Illinois.
13. Northville Station, Michigan.
14. Alpena Station, Michigan.
15. Baird Station, California.

The following stations were under construction or repairs with a view to their occupation the present season:

1. Baird Station, California.
2. Clackamas River Station, Oregon.
3. Neosho Station, Missouri.
4. Duluth Station, Minnesota.

The stations in active operation during the present fiscal year are as follows:

1. Schoodic Station, Maine.
2. Craig's Brook Station, Maine.
3. Gloucester Station, Massachusetts.
4. Wood's Holl Station, Massachusetts.
5. Cold Spring Harbor Station, N. Y.
6. Battery Island Station, Maryland.
7. Fort Washington Station, Maryland.
8. Central Station, Washington, D. C.
9. Fish Ponds, Washington, D. C.
10. Wytheville Station, Virginia.
11. Sandusky Station, Ohio.
12. Quincy Station, Illinois.
13. Northville Station, Michigan.
14. Alpena Station, Michigan.
15. Duluth Station, Minnesota.
16. Clackamas River Station, Oregon.
17. Baird Station, California.

The station at Baird, Cal., for the collection of the eggs of the rainbow trout, having served its purpose, was discontinued.

The oyster-cultural station at St. Jerome's, Md., was abandoned, the results obtained not justifying the expenditure required.

The station at Neosho, Mo., was under construction, but not completed at the close of the fiscal year.

Additional stations were authorized by Congress, and provisions made for them by special appropriations in the sundry civil bill, which became a law March 2, 1889, as follows:

Fish-hatchery, Maine.—For the purchase of ground, construction of buildings and ponds, and purchase of equipment of fish-hatchery and rearing stations near Craig's Brook, Reed's Pond, and Branch Pond, Maine	$11,000
Fish-hatchery in Lake County, Colorado.—For the construction of a Government trout-breeding and distributing station in Lake County, Colorado	15,000
Fish-hatchery on Lake Erie.—For the purpose of establishing and equipping a station at some convenient point on Lake Erie, to be designated by the Commissioner of Fish and Fisheries, for the taking of spawn and the propagation of whitefish	20,000

These stations when completed and in operation will require annually an aggregate expenditure of $18,000, which must be provided for by a corresponding increase in the appropriation for the propagation of food-fishes; the present appropriation of $130,000 is barely adequate to provide for the expenses of the general administration and the maintenance of stations now in operation.

SCHOODIC STATION, MAINE.

Mr. Charles G. Atkins, the superintendent of Craig's Brook Station, also has charge of the Schoodic Station, at Grand Lake Stream. This latter station is devoted to the collection and distribution of landlocked salmon eggs, and is conducted jointly by the United States, New Hampshire, and Massachusetts. The routine work was begun by the foreman, W. H. Munson, September 3, 1888. Frequent rains in the fall of 1888 delayed operations. Between October 24th and November 24th, 974 breeding salmon were taken in barrier and pound nets. Exactly one-half of these were males; 963,900 eggs were taken, which were divided as follows: To Massachusetts, 14,000; to New Hampshire, 65,000; to the United States, 510,000. The share of the United States was distributed as follows:

To Maine Commission	25,000
To New York Commission	100,000
To New Hampshire Commission	65,000
To Plymouth, N. H., for distribution on account of the United States	50,000
To Minnesota Commission	25,000
To Iowa Commission	25,000
To Michigan Commission	100,000
To Deutscher Fischerei Verein	50,000
To Richard Young, Edinburgh, Scotland	25,000
To Wytheville Station, Va	30,000
To Duluth Station, Minn	50,000
To Central Station, Washington, D. C	30,000

On account of the warmer temperature of the spring water, the eggs matured earlier than they usually do in the river hatchery, and shipments were begun January 29, 1889, and completed February 5. There were retained 204,365 for Grand Lake Stream and its tributaries; the work was completed June 22. The distribution of Schoodic salmon fry was as follows:

Date.	No.	Age.	Where deposited.
Oct. 16, 1888	2,349	Six months	Craig's Pond.
Oct. 17, 1888	2,021	....do	Do.
Oct. 26, 1888	1,281	Eight months	Do.
May 28, 1889	333	Thirteen months	Do.
Total	5,984		

The eggs reserved at Schoodic Station counted 211,100. From these about 205,000 fish were hatched at the joint expense of the United States and New Hampshire, and liberated in Grand Lake and Grand Lake Stream in June, 1889. May 27th, 153 landlocked salmon, thirteen months old, were deposited in the same waters.

The 200,000 eggs of the Penobscot salmon sent from Craig's Brook Station to the Schoodic Station yielded about 198,000 fry, which were liberated in Grand Lake and connecting waters in June, 1889.

CRAIG'S BROOK STATION, MAINE.

This brook empties into Alamoosook Lake, which discharges its waters through Narramissic or Eastern River into the Penobscot near its mouth. The mouth of the brook is about 3 miles from the head of tide water at Orland. Experiments in salmon-culture in the United States began near the mouth of the Penobscot in 1871, and Craig's Brook became the place of inclosure for breeding fish. The work was temporarily removed to another hatchery near Bucksport, but the original location was again occupied in 1879. In 1886 the operations at Craig's Brook were extended to include the feeding and rearing of *Salmonidæ* in troughs and ponds; but this work was temporarily suspended because the superintendent of the station, Mr. Charles G. Atkins, was assigned to duty elsewhere.

In 1888 the plan was revived, and it was decided to buy the farm inclosing Craig's Brook and establish a permanent station for rearing *Salmonidæ*, and especially the Atlantic salmon. One hundred and thirty-five acres of land, inclosing both banks of the stream for its entire length, were leased with the privilege of purchase; and in April, 1888, the superintendent began preparations for the season's work. Breeding Atlantic salmon were confined as usual at Dead Brook. Between May 27th and June 10th, 612 salmon were bought and placed in the inclosure. Of these, 435 were retaken in October and November; 255 females, averaging 15.43 pounds in weight, yielded 2,253,206 eggs, of which

85,906 died during development. The remainder were divided among the subscribers, as follows: U. S. Fish Commission, 1,527,600; Massachusetts, 290,000; Maine, 350,000; reserved at Craig's Brook for rearing, 132,600; packed and shipped as indicated in the tables of distribution, 1,395,000.

The following stock of fish and embryos were retained for breeding:

Atlantic salmon:	
One year old	1,520
In the egg	109,965
Landlocked salmon:	
One year old	80
In the egg	26,191
Rainbow trout in the egg	2,500
Brook trout in the egg	4,000
Total	144,256

Forty open-air troughs were added to the accommodations. Arrangements were made to feed them on maggots and chopped meat, the use of entomostraca, insect larvæ, etc., having been abandoned because of the expense involved in getting them. The fish began to feed June 1. Fungus did not make its appearance, and the loss in this month was unusually small.

Five thousand eggs of the Atlantic salmon were sent from Craig's Brook to Mr. E. G. Blackford, New York, for transshipment to Quito, Ecuador.

Coregonus albula.—Of this little German whitefish, 51,000 one month old were planted in Heart Pond, Maine, April 21, 1888, by Mr. Atkins.

Atlantic salmon.—The distribution of young salmon of this species was as follows: 1888, October 16, to December 15, 13,498 six to eight months old in tributaries of the Alamoosook Lake, Orland, Maine. May 3, 1889, 310 one year old, same waters.

GLOUCESTER STATION, MASSACHUSETTS.

The active operations at this station, which is under the superintendency of E. M. Robinson, are confined to the winter and early spring. During the rest of the year it is closed and in charge of a custodian. The station was occupied with a working force about the middle of October, necessary repairs made, and equipment overhauled and put in order.

Cod.—On November 3, the first codfish eggs were taken, and the work continued until March 15, 1889. The percentage of loss was very large, which was attributed to the fact that many of the eggs were killed by exposure to severe weather; moreover, frequent storms roiled the water, and mud in suspension, being carried into the hatching boxes, adhered to the eggs and destroyed their buoyancy. Total number of eggs taken, 45,000,000; lost in incubation, 28,000,000; transferred to the Wood's Holl Station, 6,000,000. Eleven million young were hatched and planted in Gloucester Harbor, near Eastern Point.

Pollock.—Experiments were made in hatching pollock eggs, with fair success considering the disadvantages in handling a species new to artificial propagation. Total number of eggs obtained, 32,000,000; lost in incubation, 25,000,000; number of fry hatched and turned out, 7,000,000. Seventeen million eggs were lost at one time in consequence of a heavy storm occurring in the latter part of November. In hatching, the best results were obtained with the McDonald tidal box, having the water turned on sufficiently strong to keep the siphon from breaking after the water had been drawn down to its lowest point.

WOOD'S HOLL STATION, MASSACHUSETTS.

This station was operated during the entire year, with Mr. John Maxwell as superintendent and Prof. John A. Ryder in charge of the laboratory. Mr. Richard Dana conducted the fish-cultural work. Important changes and improvements were made in the pumps and boilers, and the electric-light plant was finished and put in operation.

Cod.—The cod work was very much hampered by the difficulty of obtaining spawning fish, and by the northwesterly gales during December and January, when many of the eggs were killed by the mud and slime.

The *Grampus* furnished 967 codfish from October 25 to November 22, 1888. These were kept in live cars and fed occasionally; and 11,640,000 eggs were obtained from them between October 29, 1888, and February 28, 1889. From the eggs kept at the station 5,871,000 fish were obtained. From the Gloucester Station 4,284,000 live eggs were received, which yielded 3,306,000 fry. Seventy thousand fry were kept in a glass aquarium twenty-two days, being fed on clam juice; but a sudden change of temperature killed them all. From dead fish were taken 148,000 eggs, which were hatched and planted.

The apparatus employed consisted of Chester hatching boxes and McDonald improved tidal boxes. The period of incubation in the McDonald apparatus averaged eighteen days; in the Chester apparatus, twenty days.

Sole.—The soles imported from England were kept at Wood's Holl until October 6, 1888, when the Commissioner personally superintended the planting of 28 individuals in Vineyard Sound, near Quick's Hole.

Mackerel.—Vinal N. Edwards, on May 21 and 24, collected 215,000 mackerel eggs, from which 185,000 fry were hatched and planted in Vineyard Sound, May 29. Eggs taken June 3 from fish which had been dead a few minutes could not be developed.

Scup.—On May 22, 50,000 eggs of this species were taken; 30,000 were hatched, and the young were deposited in Wood's Holl Harbor, May 29.

Sea bass.—From the 5th to the 10th of June, 1,150,000 eggs were collected. Of these 1,025,000 were hatched, and the fry were planted between June 10 and 13.

Lobster.—Between the 30th of April and the 26th of June 3,059,000 lobster eggs were taken from 330 females; 1,574,000 fry were hatched from these and planted in the vicinity of Wood's Holl. The hatching apparatus used were the Chester inverted jars, the McDonald improved hatching box, and the McDonald hatching jar, the latter being the most successful. Seven hundred and ten adult lobsters were packed in seaweed in 104 wooden crates and shipped to the Pacific coast on car No. 3 on January 14, 1889; 431 of these were females, 63 of them having their eggs fertilized. On the way about 500 died, and the remainder, of which 54 were females with eggs, were planted in Puget Sound. The attempt to rear young lobsters at the station was again unsuccessful.

COLD SPRING HARBOR, NEW YORK.

This station is owned and operated by the New York fish commission, but the privilege is granted to the U. S. Fish Commission to send here eggs of Atlantic salmon, landlocked salmon, lake trout, etc., to be hatched and distributed under the direction of the superintendent. The fry of these species were planted, with a single exception, in New York waters. Eggs of California, Atlantic, and landlocked salmon intended for shipment to foreign countries were repacked at this station and forwarded to their destination. The results of stocking the Hudson River with Atlantic salmon were reported by Mr. Fred Mather, superintendent, in the Bulletin for 1887, page 40.

Eggs of brown trout and sälbling were received from Germany and distributed in accordance with instructions from the Commissioner.

Landlocked salmon.—From Schoodic Station were received 50,000 eggs of this salmon; 25,000 of these were sent to the Sacandaga hatchery. The eggs kept at Cold Spring Harbor furnished 22,344 fry, of which 10,000 were planted in Lake Ronkonkoma, Long Island, and 10,000 in a lake in Passaic County, N. J; the remainder were kept at the station, where they thrived until May 10, when they began to die suddenly and in large numbers and the survivors were liberated in the rearing ponds.

California salmon.—A few eggs were kept for hatching from those received for foreign shipments. In May, 1889, 1,350 fry were planted in Lake Ronkonkoma, Long Island, which has no outlet and has depths of 60 to 64 feet.

Lake trout.—Between December 26 and 31, 1888, were received from Northville, Mich., 450,000 eggs of lake trout. The resulting fry, 430,000 in number, were planted in Suffolk, Putnam, and Hamilton counties, N. Y.

BATTERY ISLAND STATION, MARYLAND.

The lease of this station (W. de C. Ravenel, superintendent) having expired in June, 1888, and Mr. T. B. Ferguson, the lessor, having declined to renew the same except upon a rental of $1,200 per annum, which was

considered unreasonable, it was determined to transfer the equipment and such of the buildings as were necessary for the work of the Commission to the breakwater constructed by the Engineer Department of the Government for the protection of the wharves and buildings of the Commission and the channel of approach from damage by floating ice. The necessary authority for such occupation was granted on request duly made to the Secretary of War, and the transfer of property and the equipment of the station completed in the spring of 1889. Certain of the property not required for use or which could not be removed was condemned by a board of survey, duly advertised and sold, and the proceeds, amounting to $374.65, covered into the Treasury.

For the convenience of the work of distribution an auxiliary station was established at Havre de Grace in the canning house of Mr. S. J. Seneca. The first eggs were taken on April 15, 1889, and from that time to May 24 nearly 58,000,000 shad eggs were obtained, over 7,600,000 eggs having been taken in one day. About 5,000,000 fry were hatched and planted near the station and 35,000,000 were distributed to other points. The difference in the number of eggs taken and the number of fry distributed represents the loss of eggs during incubation.

FORT WASHINGTON STATION, MARYLAND.

The operations at this station were again under the charge of Mr. S. G. Worth. The egg-collecting season began April 12, and continued until May 17. The total number of eggs taken was 58,233,000. The eggs were not measured until thirty-six hours old, so that the number stated represents impregnated eggs. Nearly one-third of the eggs were furnished by the Fish Commission seine at the station, an equal number was obtained from the fishing shores, and the remaining eggs, upward of 20,000,000, were received from the gill-net fishermen. A freshet suspended the egg-collecting for a week in the middle of the season. On the three days preceding the freshet, April 22 to 24, the daily average take of eggs was 4,500,000; but from April 25 to May 1 only 2,922,000 were collected. Mr. Worth notes great gluts of eggs, 8,368,000 on May 6, and 6,311,000 on May 7. During the seven best collecting days, an average of over 5,000,000 per day was secured.

CENTRAL STATION, WASHINGTON, D. C.

This station, with S. G. Worth as superintendent, is located in the Armory Building. Besides containing the offices of the Commission, this building is the scene of many other important operations. Shad eggs are received here from Fort Washington Station, to be hatched and distributed. Eggs of whitefish, salmon, and trout are hatched and forwarded to eastern waters. Carp, goldfish, and other species of the carp family, and various important food-fishes of the Mississippi Valley, including catfish, black bass, rock bass, and crappie, are sent

here for distribution. Three cars, which were built expressly for the purpose, are engaged in transporting fish and eggs to and from this station. The steamer *Fish Hawk* and the launch *Blue Wing* are occupied part of the time in bringing supplies of various kinds, including fish and eggs, to Washington for the Central Station. The building is also the depot into which come all the natural-history collections and records of physical investigations made by the schooner *Grampus* and the steamers *Fish Hawk* and *Albatross.*

At this station will be found illustrations of fish-culture and fishery methods, together with the appliances and results of scientific inquiry. This is supplementary to the exhaustive permanent exhibit of the U. S. Fish Commission in the Fisheries Department of the National Museum. Fish-cultural work is shown by the actual hatching of several species, by models of apparatus now in use and formerly employed, and by means of photographs. The appliances and methods of the fisheries and of the scientific inquiry are at present illustrated chiefly by means of photographs; but it is the intention to develop these features as rapidly and fully as possible. For the investigation and illustration of scientific and fish-cultural problems, and for the gratification of visitors, the aquaria have become an invaluable resource. Their future utilization for experiment and observation promises most valuable results.

During the present fiscal year the following adult fish, fry, and eggs have been distributed through this station:

Fingerlings:		Fingerlings:	
German carp	190,928	Brook trout	125
Goldfish	7,440	Fry:	
Golden ide	7	Shad	23,404,000
Tench	1,532	Whitefish	4,595,000
Spotted catfish	301	Lake trout	38,000
Garfish	37	Brook trout	21,000
Black bass	20	Landlocked salmon	28,600
Rock bass	1,174	Eggs:	
Rainbow trout	10,160	Shad eggs	11,097,000

Two heavy freshets in the Potomac River in 1889 greatly reduced the fish supply.

Extensive improvements were made in the hatching facilities of the station, including an increased water supply, permanent aërating apparatus, enlargement of the machine room and storage quarters, and, in general, bringing the station to a point of efficiency not excelled by any other.

Aquaria.—In October a small grotto was constructed in the doorway at the western end of the building; this contained 16 running feet of glass frontage. For some weeks marine fishes were successfully maintained by means of air circulation. Immediately thereafter a similar grotto for fresh-water species was constructed in a doorway on the south side, and finally in January an annex for marine species the full

length of the west end of the building. Twenty-four special aquaria were built at the station and occupy 130 running feet in the annex. Besides being carefully fitted into paper work of massive and ornamental character, in imitation of stone, the whole was housed in with glass, requiring a considerable amount of varied work. In addition to the above, twelve large and substantial aquaria were constructed for the reception of fry on the hatching tables.

Preparations for Expositions.—During the year exhibits were sent to the Ohio Valley Exposition, held at Cincinnati, and to Augusta, Ga. More than a month's time was spent in preparing for the Cincinnati exhibition, all the station employés and also outside help being engaged.

FISH PONDS, WASHINGTON, D. C.

Mr. Rudolph Hessel, superintendent, accompanied the original importation of carp from Germany to the United States and has been in charge of the breeding and rearing ponds in Washington since they were first established. The total area under pond cultivation is now about 19 acres. The entire production of carp, goldfish, and tench in 1888 was 200,000, or about 10,000 to the acre. In 1889 the promise of increased production was very favorable, but an unusual flood in the Potomac submerged the ponds to a depth of 9 or 10 feet, and the greater portion of adult and young fish escaped into the river. At the same time many of the native fishes of the Potomac obtained entrance into the ponds, and preyed upon the young fish which had not escaped during the season of high water. As a result, the production of the ponds for the year was small, and only a limited proportion of the requests on file for carp and goldfish could be supplied.

Shad.—Nearly 3,000,000 shad fry were placed in the west pond in May, 1888. These were held in the ponds during the summer, but were not fed; on the natural food found in the ponds they made rapid growth. In October, when the young shad were released in the Potomac River, they had attained an average length of 3 inches. It was not possible to determine by actual count the number of fish liberated, but conservative estimates placed the number at 50 per cent of the number of fry placed in the pond. These results were as satisfactory as they were unexpected, and indicated a new departure in fish-cultural work, which promises important consequences.

In April, 1889, the same pond was stocked with about 4,000,000 shad fry. These had by the 1st of June attained a length of three quarters of an inch, when a flood swept the entire crop into the river. Only a few hundred remained in the pond, and these, when the water was drawn off in October, had acquired a length of from 6 to 8 inches, thus illustrating, in a very striking way, the rapid growth made by fishes when there is an abundant supply of food, and other conditions are favorable.

WYTHEVILLE STATION, VIRGINIA.

This station has been occupied, as heretofore, under lease from the State of Virginia, and George A. Seagle was continued as superintendent. The black bass, which were collected and placed in the ponds the previous fall, spawned this season for the first time, but all the young and a part of the breeding fish were lost through the overflow of Tate's Run, which also damaged the ponds and caused a considerable loss of carp, perch, and goldfish. The cultivation of the brook and brown trout proved to be unprofitable, and was therefore discontinued. On October 1, 1889, Mr. Seagle estimated the fish on hand to be as follows: Rainbow trout, 56,000; brook trout, 1,000; carp, 5,000; rock bass, 6,000; goldfish, 500.

Rock bass.—There were taken from the ponds 6,628 fish, and 400 adults were collected from Wolf Creek. To Central Station were forwarded 100 fish two and three years old; 4,300 yearlings were distributed to North Carolina and Virginia.

Landlocked salmon.—Early in February 30,000 eggs were received from Schoodic Station, Me., of which 28,700 were hatched; 4,950 fry were planted in Reed Creek, Wythe County, Va. The loss of fry in the hatchery up to June 30 was very great.

Rainbow trout.—From the first week in December, 1888, to March 25, 1889, 314,000 eggs were taken. Of these 40,000 were sent to England and France, 69,500 to various places in the United States, and 148,000 were hatched at the station. In the waters of Virginia, Kentucky, and Georgia, 46,000 yearlings were planted, and 1,900 were sent to Central Station for distribution.

Brook trout.—From the 23,800 eggs received from Northville, and the 42,000 taken at this station, were obtained 24,400 fry, which were released in the ponds; 500 yearlings also were planted in Virginia, and 185 were sent to Central Station for distribution.

Lake trout.—575 of this species were deposited on December 31, 1888, in Salt Ponds, Giles County, Va.

Grayling.—Six adults of this species were sent from Wytheville to the Cincinnati Exposition, and six to Central Station.

Carp.—The ponds yielded over 20,000 during the season of 1888–89, and 18,315 were distributed to applicants in Virginia, Tennessee, Mississippi, and Florida.

Goldfish.—Of 5,600 goldfish, over 3,000 were sent to applicants in the Middle and Southern States. Owing to the cold and cloudy weather only a small percentage of the goldfish colored.

SANDUSKY STATION, OHIO.

By agreement with the Ohio fish commission the U. S. Fish Commission took charge of this hatchery during the season of 1888–89. The species propagated included the whitefish (*Coregonus clupeiformis*)

and the pike perch (*Stizostedion vitreum*). Mr. Henry Douglas is superintendent of the station.

Whitefish.—Eggs were collected at Toledo and the Lake Erie islands from November 3 to November 28, 1888. On November 8 and 9 the temperature was 14° higher than upon these dates in 1887, and 75,600,000 eggs were lost thereby; the loss was made good by later collections. Eggs were distributed as follows:

Date.	Destination.	Number.
Nov. 9, 1888	Pennsylvania, hatchery at Erie.	9,000,000
Nov. 22, 1888	do	6,400,000
Dec. 22, 1888	do	9,000,000
Dec. 28, 1888	do	9,000,000
		33,400,000

Forty million seven hundred thousand whitefish were hatched at Sandusky and the fry deposited in the western end of Lake Erie, from March 22 to April 1, 1889.

Pike perch.—Eggs of this species were collected from April 10 to 25, 1889, at Toledo and the islands. About 90,000,000 were obtained, of which 60,000,000 were hatched; but 10,000,000 were lost through lack of facilities for shipping them. Eggs have been taken at Sandusky during six years ending with 1889, but never before in such large numbers. The following distribution of fry was made:

Date.	Destination.	Number.
Apr. 29, 1889	Illinois waters	12,000,000
May 4, 1889	Ohio waters	16,400,000
May 7, 1889	Pennsylvania waters	12,000,000
May 8, 1889	Ohio waters	10,000,000
		50,400,000

QUINCY STATION, ILLINOIS.

During the winter of 1887–88 the attention of the Commissioner was attracted to the work done by the Illinois State fish commission in the collection and distribution of the native food-fishes of the Mississippi Basin. The overflow ponds and lakes formed during the seasons of high water are the fruitful nurseries of the young of the crappies, the basses, the pike perch, the yellow perch, and the spotted catfish. Here they grow rapidly, until, with the contraction of the water areas and the increasing demands for food, the waters become overstocked and they die in countless thousands by starvation, or perish by the drying up of the ponds during the season of summer drought. It was recognized that these natural nurseries furnished ready to our hands, at little comparative cost, an immense supply of choice food-fish and well adapted by their habits and conditions of life to the more sluggish streams of

the interior, whence they have in many cases disappeared by reason of the obstructions in the course of the waters, or by the improper and wasteful methods of fishing pursued.

When it was proposed by the very efficient superintendent of the Illinois commission, Dr. S. P. Bartlett, that the U. S. Commission should tentatively undertake the work of collection and distribution, coöperating with the State commission and sharing expenses and results, his proposition was accepted, and a detail of cars and men was sent to Quincy, where headquarters were established, and the work of collection and distribution carried on for several weeks. The results have been so satisfactory and compensating that it has been determined to greatly extend operations in the future, having special reference to the needs of those States which receive only indirect and remote benefit from the work of our regular fish-cultural stations.

NORTHVILLE STATION, MICHIGAN.

Mr. Frank N. Clark, superintendent of the Michigan stations at Alpena and Northville, reports better aggregate results at these stations during the last year than any other year since their establishment. In the distribution of partially grown fish the success has been most marked; and Mr. Clark mentions an experiment in planting yearling brook trout which clearly shows the wisdom of this method of stocking streams. The entire yield of the season was 47,771,411 eggs and fish, of which nearly 45,000,000 were whitefish, and upward of 2,000,000 lake trout.

Whitefish.—In 1888 it was decided to devote the Northville Station wholly to trout and transfer the whitefish operations to Alpena. During October, however, operations were authorized on Detroit River in penning whitefish from the seines and holding them until they were ripe. Three penning stations were selected, and 4,500 fish were inclosed, from which were obtained 15,000,000 eggs of an inferior quality, because of very warm weather. Many of the fish died before their spawn was secured. This was said to be the warmest season known on the Detroit River. The whitefish work has therefore not been so satisfactory as in former years.

Von Behr trout.—Eighty-four thousand four hundred eggs of this species were obtained from 131 females between October 31, 1888, and January 4, 1889, or more than three times as many as were secured the previous year. Seventy of the females were yearlings. A female weighing 4½ pounds yielded 4,800 eggs; but the average yield was 644 eggs each. On July 1, 1889, there were 40,000 fry in the feeding tanks, which had been kept since April.

Loch Leven trout.—From 410 females there were obtained 225,125 eggs, an average of 556 each. The season opened October 28, 1888, and closed January 4, 1889. Of these eggs 120,000 were shipped as follows: Wisconsin commission, Madison, 30,000; New Hampshire commission,

Plymouth, 30,000; Nebraska commission, South Bend, 30,000; Pennsylvania commission, Corry, 30,000. The balance were hatched at Northville, yielding 89 per cent of fry. The Loch Leven trout is thriving at this station. The stock of breeders will soon be increased, as 6,000 healthy yearlings are now on hand.

Rainbow trout.—The distribution of one-year-old rainbow trout from the Northville Station included upwards of 53,000 fish, which were liberated in streams of Michigan, Ohio, Indiana, Iowa, Nebraska, and Tennessee. Fewer eggs were taken than last year, but the yield next year should be greatly increased, because in addition to the old breeders the station now has 1,500 trout two years old. The breeding females numbered 223, and yielded 204,400 eggs, an average of about 900 each. There were distributed 57,500 eggs between February 18 and April 2, of which 10,000 were sent to E. Cházari, national commissioner of fisheries, City of Mexico.

Brook trout.—The egg-taking began October 20 and continued until January 7. Females numbering 945 furnished 332,950 eggs, averaging about 350 each. More than one-third of the eggs were obtained from yearlings. The shipments of eggs aggregated 207,000. Among these were 25,000 to William Burgess, London, England; and 10,000 to E. Cházari, City of Mexico. The States receiving eggs of this species were Minnesota, Ohio, Delaware, New Jersey, and Massachusetts. The number of yearling brook trout distributed from January 13 to April 1, 1889, was 13,875, besides 1,000 which were held at the station.

Lake trout.—The main supply of eggs for the Northville hatchery was obtained at Thompson on Lake Michigan. The first eggs were taken October 16, and the season continued until November 15, when the hatchery contained 3,400,000, the greatest number ever laid down in one season. There were taken also in Lake Huron, near Alpena, 300,000. On December 21, 1888, 50,000 eggs were sent from Northville to E. Cházari, City of Mexico.

ALPENA STATION, MICHIGAN.

The season was one of the most successful recorded. From the egg-collecting stations on lakes Huron and Michigan upward of 45,000,000 whitefish eggs were obtained, completely filling the hatchery. More than 20 men were employed as spawn-takers during the season, which began November 1. In April and May, 1889, 23,320,000 whitefish fry, reared at Alpena, were deposited in lakes Huron and Michigan.

Lake trout.—In the fall of 1888 Mr. William Bolton, of Alpena, collected 150,000 shoal trout eggs, which were hatched at Alpena and planted in Long Lake; the expense was borne by private parties. In March, 1889, about 80,000 fry were liberated in Long Lake.

DULUTH STATION, MINNESOTA.

As announced in the last report, the hatchery building at Duluth was let to contract on May 21, 1888. The construction of the building was begun under the supervision of Mr. George Tolbert. On September 9, 1888, Dr. R. O. Sweeny was appointed superintendent, and reported at the station. The completed building was accepted from the contractors, Messrs. James Carlisle & Sons, of Minneapolis, January 15, 1889, and was received into the custody of the superintendent.

The grounds are located on the left bank of Lester River, at its mouth, where it enters into Lake Superior. The hatchery is built of wood upon stone foundations. It is divided into three portions: the front is 38 feet wide and 21 feet deep; the remainder of the building is 60 feet long and 30 feet wide, except the rear 18 feet, which is 34 feet wide. The front and back ends are two stories high and connected by a low attic. The stone basement contains the coal room, pump and boiler room, etc.

On the first floor is the hatching room, 60 by 32 feet, located in the back part of the building, facing the lake. In a room occupying the rear gables it is intended to place an elliptical tank, into which water will be pumped from the lake until a supply can be obtained from Lester River. From this tank the water will be distributed through pipes to the hatching and rearing apparatus in the room below. The present water supply is pumped from Lake Superior at a point nearly opposite to the hatchery. It is intended in the future to construct a dam in Lester River and convey the water through a flume to a reservoir in the hatchery grounds. Permission has been obtained from the Duluth and Iron Range Railroad Company to support this flume upon their bridge where it crosses Lester River. The hatchery is supplied with 400 jars, capable of accommodating 60,000,000 whitefish eggs. It is intended to establish collecting stations for whitefish eggs in Lake Superior, but arrangements for this could not be perfected the present season.

The following consignments of eggs were received and hatched at the station during the season:

Description.	Source of supply.	Date.	Number.
Whitefish ova	From Sandusky hatchery	Jan. 3	4,500,000
Do	From Alpena station	Feb. 28	5,000,000
Lake trout ova	From Northville station	Jan. 3	500,000
Do	From Alpena station	Feb. 28	500,000
Landlocked salmon ova	From Schoodic station		50,000
Von Behr trout ova	From Germany		50,000
Sälbling ova	do		9,000

The landlocked salmon, whitefish, and lake trout fry were planted in Lake Superior in localities adjacent to the station. The fry obtained from the Von Behr trout and sälbling eggs were held at the hatchery until the end of June and then transferred to the Minnesota State

hatchery, the State commission kindly affording accommodations for them until suitable ponds could be prepared for them at the Duluth station.

Pike perch.—During the spring of 1889 the superintendent collected 25 quarts of the eggs of this species. These were hatched with fair success, and about 3,000,000 fry were obtained, which were planted off the north shore of the lake about 2½ miles above Lester River. The work of the present season was preliminary to much more extended operations with this important food species. Eggs intended for development at Duluth were provisionally sent to Northville to be cleaned up and forwarded to Duluth when the station was ready.

NEOSHO STATION, MISSOURI.

The resolution of Congress directing the Fish Commissioner to select a site for a fish-cultural station in the Ozark region of southwest Missouri, the exploration of that country in pursuance of the order of Congress, and the provision in the sundry civil bill for the construction of an establishment and its maintenance for the fiscal year ending June 30, 1889, are fully set forth in the last report.

By act approved October 2, 1888, an appropriation of $8,000 was made for the construction of buildings, ponds, and appliances for a fish-cultural station at Neosho, Mo. On December 7, 1888, a certificate of title for the land required was approved by the Attorney-General of the United States. On November 19, 1888, Lemuel B. Herrell and his wife executed a deed to the United States transferring a part of the northwest quarter of the northeast quarter of section 30, township 25, range 31 west, fifth principal meridian, containing about $12\frac{36}{100}$ acres, more or less. By a subsequent deed of December 17, 1888, a strip of land 25 feet wide on each side of this spring was transferred to the United States, in order to insure control of the water supply.

The consideration for these pieces of property was $2,472.43, and this was paid by the city of Neosho. In securing this land the Commission was greatly indebted to the services of Hon. Lee D. Bell, mayor of the city. On January 12, 1889, the engineer of the Commission began a survey of the tract of land, and prepared a map giving the relief of the ground and indicating the best method of introducing the water from Herrell Spring into the grounds. On February 1, 1889, Mr. W. F. Page was appointed superintendent of construction, and left Washington February 24, to begin the establishment of ponds, laying out of roads, etc. On March 6, 1889, an act introduced in the legislature of Missouri by Representative Gallemore, of Newton County, ceding jurisdiction to the property occupied by the United States as a fish-cultural station, became a law of the State. On March 18, 1889, Mr. George H. Tolbert was assigned to duty at Neosho, to assist the superintendent. The rest of the fiscal year was devoted to inclosing the property and constructing ponds and roads and wooden piping for the introduction of the water supply.

LEADVILLE STATION, COLORADO.

A station for breeding and rearing trout in the Rocky Mountain region having become a necessity, the Commissioner made a careful examination of the country available for the purpose and decided to locate the station in Colorado. The site selected is in Lake County, near Evergreen Lakes and about 6 miles west of the city of Leadville. By act of Congress approved March 2, 1889, the sum of $15,000 was appropriated for the purpose of erecting a hatchery building in Colorado. A Government reservation for the use of the U. S. Fish Commission was created by proclamation of President Harrison dated April 16, 1889, and consists of 1,935 acres, beginning on the western edge of the Arkansas Valley and extending to the top of Mount Marcy, 14,298 feet above tide water, so as to include the upper valley of Rock Creek, which has its sources in an extensive permanent ice and snow field, lying in a depression on the flank of the mountain. Detailed plans and specifications have been prepared, and the work will be contracted for at an early date.

BAIRD STATION, CALIFORNIA.

No active fish-cultural operations were carried on at this station from 1883 to 1888. The work had been undertaken chiefly with the object of procuring the eggs of the California salmon for the purpose of stocking our eastern rivers flowing into the Atlantic and the Gulf of Mexico. It was thought probable that this species would thrive in rivers south of the Hudson, in which the Atlantic salmon does not occur naturally and in which the attempts by the Federal and State commissions to introduce the species have not proved successful. These experiments were undertaken on a scale unprecedented in the history of fish-culture. Millions of eggs were transferred to the eastern stations, hatched out, and the fry planted in nearly every one of the larger rivers south of the Hudson. In no single case did the experiment prove satisfactory, and the Commissioner was forced reluctantly to abandon an experiment which, reasoning from *a priori* considerations, gave fair promise of success, and which, had it succeeded, would have given us a new and valuable fishery in the Atlantic rivers.

The work was resumed in 1888, with Mr. G. B. Williams as superintendent, with the definite purpose of aiding in the maintenance of the salmon fisheries of the Sacramento River, which had been for several years rapidly deteriorating. All necessary preparations for work were completed by the middle of August, when the capture of gravid salmon began and continued until September 24, when the first run of salmon ceased. The second run began October 29 and continued until December 15, when the fishing ceased. The total number of eggs taken was 5,500,000, the second run of fish furnishing 4,000,000 of these (in previous years the eggs were obtained entirely from the first or August

run); 3,320,000 were transferred to the State hatchery at Sisson, the State commission completing the work of developing, hatching, and distributing at their own expense; 2,000,000 were retained and hatched at the station and planted in the McCloud River; 100,000 were forwarded to the Society of Acclimation of France through the intervention of Mr. Eugene G. Blackford, commissioner of fisheries for New York, and arrived at their destination in excellent condition.

The racks placed across the river at the station completely arrest the ascent of salmon and enable us to judge with reasonable accuracy as to the number of fish in the river. The August run this year was much less than usual, and is to be attributed to the fact that the State has abolished the close time in August and substituted for it a close time in September, when the first run of salmon is over.

CLACKAMAS STATION, OREGON.

Deeds to this property were given April 13 and November 28, 1888. Subsequent proceedings, made necessary by the death of some of the devisees, delayed its final acquisition until February 22, 1889. In the meantime, however, Mr. Livingston Stone proceeded to operate the station as agent of the U. S. Fish Commission. On July 1, 1888, Mr. Waldo F. Hubbard was engaged as acting superintendent. During the summer various repairs and improvements were made. The property purchased from the Oregon fish commission for the sum of $5,155.60 included a rack 400 feet long, a dam across Clear Creek 160 feet long, a flume 16 inches square conducting water to the hatchery (a distance of 1,800 feet), filtering tanks, a dwelling-house, a house for workmen, a hatching-house, and a stable, all in good condition. The hatching-house is a wooden building 40 feet wide and 100 feet long, having a capacity for 6,000,000 eggs, and the water supply is sufficient to hatch 30,000,000.

On account of the great number of salmon which collected at the rack, it became necessary to guard them day and night from poachers. The station is located at the mouth of Clear Creek, on the Clackamas River, a tributary of the Willamette, which empties into the Columbia about 180 miles from its mouth. By the consent of the Oregon commissioners the egg-collecting and hatching continued until the middle of November, when the station was turned over to the Oregon fish commission to complete the work of the season at their own expense. Some difficulty was experienced with the water supply from Clear Creek until the fall rains set in about the middle of October, a deficiency which Mr. Stone would obviate by utilizing the water from a small tributary of the creek and the construction of a temporary hatching-house large enough to carry all the eggs prior to the fall rains. An additional supply could be obtained also by using the power furnished by the surplus water from the Clear Creek flume to pump water from the river.

On August 25 the first good eggs were secured, and from that date

to November 2 over 4,500,000 were taken; of this number about 1,500,000 were hatched and planted in the Clackamas and its tributaries, and the remainder were turned over on November 17 to Mr. F. C. Reed, of the Oregon fish commission, who hatched and planted about 3,000,000 in the tributaries of the Clackamas.

STATE FISH COMMISSIONS.

It has been the policy of the U. S. Fish Commission in the develop ment of its work of stocking the waters of the country with desirable food-fishes, to coöperate as far as possible with the various State commissions. In pursuance of this plan, during the winter of 1888–89, 3,320,000 eggs of the quinnat salmon were delivered at the State hatchery at Sisson, Cal., and the fry therefrom were distributed by the California commission. In conjunction with the same commission the experiment was also made of transferring lobsters from the Atlantic to the Pacific sea-board.

As in previous years, the propagation of the Schoodic salmon was continued at Grand Lake Stream, Maine, conjointly with the States of Maine, Massachusetts, and New Hampshire.

The New York commission coöperated in the important experiment of stocking the Hudson River with salmon.

The State commission of Ohio aided the conduct of operations with whitefish and pike perch on Lake Erie, and transferred the charge of its hatchery at Sandusky, Ohio.

In the collection and distribution of the fishes native to the Mississippi Basin, the United States commission received the hearty coöperation of the Illinois Commission.

PUBLICATIONS AND LIBRARY.

The editing of the publications of the Commission and their passage through the press continue under the charge of Dr. Tarleton H. Bean, the ichthyologist of the Commission. Under his supervision the issuance of the articles bearing upon the researches and operations of the Commission has been greatly facilitated, and the knowledge conveyed therein has been promptly placed before the general public and those specially interested.

In advance of the completion of the Report of the year 1886 and the Bulletin for the year 1887, the following papers, constituting part of the same, were issued in pamphlet form:

The American Sardine Industry in 1886. By R. Edward Earll and Hugh M. Smith. (Bulletin for 1887, pp. 161 to 192.)

Notes on Entozoa of Marine Fishes of New England with Descriptions of Several New Species. By Edwin Linton. (Report for 1886, pp. 453 to 511.)

A Review of Sciænidæ of America and Europe. By David Starr Jordan and Carl H. Eigenmann. (Report for 1886, pp. 343 to 451.)

A Review of Flounders and Soles (*Pleuronectidæ*) of America and Europe. By David Starr Jordan and David Kop Goss. (Report for 1886, pp. 225 to 342.)

The Sea Fisheries of Eastern North America. By Spencer F. Baird. (Report for 1886, pp. 3 to 224.)

Lists of Dredging Stations in North American Waters from 1867 to 1887. By Sanderson Smith. (Report for 1886, pp. 873 to 1017.)

Report on the Medusæ collected by the U. S. Fish Commission Steamer Albatross in the Region of the Gulf Stream in 1885 and 1886. By J. Walter Fewkes. (Report for 1886, pp. 513 to 536.)

Report on the work of the U. S. Fish Commission Steamer Albatross for the year ending December 31, 1886. By Lieut. Commander Z. L. Tanner, U. S. N. (Report for 1886, pp. 605 to 692.)

Report on the operations at the Wytheville Station, Virginia, from January 1, 1885, to June 30, 1887. By Marshall McDonald. (Report for 1886, pp. 793 to 800.)

The distribution of the publications of the Commission during the year was, of Annual Reports, 1,360; Annual Bulletins, 313; Fisheries and Fishery Industries of the United States, 4,231; and of pamphlet articles, about 2,700.

The accessions to the library, which were secured mainly by gift and exchange for publications of this Commission, including pamphlets, periodicals, and bound volumes, were as follows: On fish, fisheries, and fish-culture, 178; on botany, geology, chemistry, and natural sciences in general, 146; making a total of 324.

COURTESIES EXTENDED AND RECEIVED.

By authority of the President, the Commission's steamer *Albatross* was placed at the disposal of the Senate Committee on Indian Affairs for an extended trip through southeastern Alaska, during the summer of 1889. Arrangements were also completed for carrying the Senate Committee on Relations with Canada to Alaska in June, but the trip was abandoned.

Materials were furnished for exhibition at the Augusta National Exposition, Georgia, the Minnesota Industrial Exposition, and the American Institute Fair.

The Navy Department has continued to assist the Commission by the detail of officers and men to its vessels and extending the facilities of the navy-yards for their outfit and repair.

The War Department continued to the Commission the privileges of the reservation at Fort Washington, Maryland, on the Potomac River, and of the breakwater near Edmonson's Island, Susquehanna River, for use as shad-hatching stations.

To the Treasury Department the Commission is indebted for many courtesies. From the Light-House Board permission was obtained to occupy the buildings on the Soldier Key Reservation, Fla., for fish-cultural purposes, and from the U. S. Coast and Geodetic Survey many copies of charts were received for use in connection with the investigations of the Commission.

The facilities of the navy-yard at Esquimalt, British Columbia, were furnished the Commission's steamer *Albatross* through the courtesy of Mr. James H. Innes, storekeeper.

Acknowledgments are also due to the Alaska Commercial Company, San Francisco, Cal., for assistance rendered agents of the Commission in the investigation of the salmon rivers of Alaska in 1889.

The work of the Commission in stocking with desirable food-fishes the various waters of the country has been greatly aided by the railroads, many of which have given instructions to their employés that messengers of the Commission be allowed access to the baggage cars, and that space be provided for cans and other accessories. In addition to these facilities, many of the roads have furnished free transportation for the cars and employés of the Commission. The following table gives the names of these roads and the number of miles for which free transportation was furnished:

Name of railroad.	No. of miles.	Name of railroad.	No. of miles.
Burlington and Missouri River	413	Lake Shore and Michigan Southern	1,262
Chicago and Alton	88	Michigan Central	2,586
Chicago, Burlington and Quincy	4,490	Missouri Pacific	1,043
Chicago and Grand Trunk	538	Mobile and Ohio	46
Chicago, Milwaukee and St. Paul	532	Northern Pacific	4,223
Chicago and Northwestern	1,247	Oregon and California	1,024
Cincinnati, Hamilton and Dayton	284	Oregon Railway and Navigation Company	856
Cincinnati, Sandusky and Cleveland	10	St. Louis, Alton and Terre Haute	62
Central Pacific	290	St. Louis, Iron Mountain and Southern	872
Detroit, Bay City and Alpena	210	St. Louis, Keokuk and Northwestern	1,133
Duluth and Iron Range	12	Texas Pacific	2,077
Flint and Pere Marquette	2,113	Utah Central	560
Fremont, Elkhorn and Missouri River	1,362	Wabash	4,337
Grand Rapids and Indiana	909	Wisconsin Central	882
Hannibal and St. Joe	1,104		
Illinois Central	580	Total	35,439
Indianapolis and St. Louis	294		

To various fishing firms of the country acknowledgment is also due for courtesies rendered to agents of the Commission in the collection of statistical and other data pertaining to the fisheries and their methods.

MARSHALL MCDONALD,
Commissioner.

REPORT UPON THE INQUIRY RESPECTING FOOD-FISHES AND THE FISHING-GROUNDS.

By RICHARD RATHBUN,
Assistant in charge.

SCOPE AND PURPOSE OF THE SCIENTIFIC WORK.

The utility of scientific research and experiment in respect to all fishery matters has been fully demonstrated by the past experience of the U. S. Fish Commission, under the able management of Prof. Baird, whose efforts to promote the welfare of this important industry by accurate and painstaking observations have proved entirely successful. The measures taken in pursuance of this object and the results accomplished from year to year have been described in previous reports, but it seems advisable, in this connection, to briefly explain the character of this scientific work in order that its direct practical bearing upon the preservation and development of the fisheries may be better understood. Science, as applied to the industrial pursuits, has not only ceased to be a pastime, but affords the only basis for intelligent and secure advancement. Nowhere is its influence more appreciable, moreover, than in the branch now under consideration, and its effects are evident both in the increase of production and in the regulation and improvement of its methods.

In accordance with the subjects to which the same relate, the scientific inquiries now in progress may be classified under four headings, as follows: (1) The development of the fishing-grounds, (2) the decrease of food-fishes, (3) the increase and dissemination of food-fishes, (4) special investigations.

THE DEVELOPMENT OF FISHING-GROUNDS.

First in sequence comes the investigation of existing fishing-grounds, whether those grounds are known to the fishermen at present or still await discovery. The purpose of this inquiry is to aid in the development of the natural fishery resources by supplying information to the fishermen as to where their work may be carried on with most profit. Fishing-grounds are distributed along the seacoasts and occur in nearly all the lakes and rivers, thereby presenting a great diversity of char-

acteristics and conditions. The most important grounds, however, are located in the seas, in the lower courses of the large rivers, and in the great lakes, some fishes living upon the bottom and others at or near the surface. Assuming the bottom grounds to be most typical, we may summarize as follows the principal information essential to the fishermen which can be gained by proper scientific observations: The position, extent, and outline of the grounds; the depth of water upon them and the character of the bottom; the kinds of useful fishes which inhabit each, and their abundance, size, and utility; their breeding and feeding habits, affecting, to some extent, their quality for food at different times; their migratory habits, which explain the periodic shifting of the grounds from one locality to another; the character and abundance of the food, and certain physical conditions upon which the permanence of the grounds depends; the distance of the grounds from markets and the meteorological characteristics of the region, as determining the period and duration of the fishing season and suggesting the character of fishing vessels to be employed; the kinds of bait best suited to each fishery and the places where sufficient quantities may be obtained.

These inquiries belong to three different branches of research—hydrography, physics, and biology, although the two former may, in a measure, be combined. Hydrography, in its limited sense, deals with the topography of the bottom, the depth of water, and other matters upon which the charting of the grounds is based. Work of this character is performed by the Coast Survey and Hydrographic Office for the benefit of commerce, but the requirements of the fisheries in this respect have not been fully met by their investigations, necessitating that the Fish Commission vessels be well equipped for the same service. The physical observations relate to the temperature and density of the water, the character, direction, and force of currents, and to atmospheric conditions and other kindred subjects. These matters, in conjunction with hydrographic features, determine the limits of faunas, and thereby the distribution of useful as well as other fishes; they also regulate the movements of migratory species and the methods of the fishermen. The inquiries regarding them are most important with respect to the more active pelagic species, such as the mackerel, bluefish, and menhaden, and the anadromous species, like the shad and salmon, but they are essential to the solution of all fishery problems, whether these relate to the oyster beds between tides or to the greatest depths frequented by food-fishes, to the river systems or to the lakes and seacoasts. The biological investigations have reference to the products of the grounds and make known the different economic species which inhabit each region, their abundance, the purposes for which they can be utilized, and the seasons during which they may be found. The character and amount of the lower forms of life existing in each locality indicate the permanence of the grounds, and to a great extent the kinds of

fishes which resort to them. The methods of the fisheries are also largely dependent upon a knowledge of the habits of the useful species.

The manner of conducting the survey of the fishing-grounds is explained elsewhere. The information obtained is presented to the fishermen in the form of charts and descriptive text, the former enabling them to locate readily any desired spot, the latter describing its principal features. Until recently the discovery of fishing-grounds has chiefly been accidental, that is to say, not due to organized and well-directed efforts, and their resources have been ascertained only through their gradual development. The rapid increase of population necessitates, however, more active progress in this direction, and all the assistance that can be afforded by such comprehensive surveys as are now under way. The investigations of the steamer *Albatross* on the Pacific coast during the past year, described below, fully demonstrate the utility of such measures.

THE DECREASE OF FOOD-FISHES.

It was specifically for the study of this subject that the Fish Commission was established in 1871, the results of its first inquiry determining the later expansion of the work. Demanding in part the same method of treatment as the survey of the fishing-grounds, it requires a much more thorough execution and a closer attention to details. In the former instance the grounds were assumed to be in their normal or natural condition, but any marked decrease in productiveness is taken as an indication that the balance of life has in some way been disturbed. It then becomes essential to ascertain what changes have occurred, the causes producing them, and the measures necessary to restore the natural conditions, finally carrying out those measures so far as practicable.

Previous to the organization of the U. S. Fish Commission it was customary, in investigating matters of this kind, to rely mainly for evidence upon the testimony of persons dependent upon the fisheries for their support, and thereby prejudiced in one direction or another. We owe chiefly to Prof. Baird the inauguration of the natural method of inquiry now prevailing, not only in this country, but also to some extent abroad. The decrease of fishes may be due to natural causes, or to injudicious practices on the part of man. The existence of a decrease having been confirmed, its extent is generally difficult to determine, from the absence of concurrent observations, and while the causes may be evident on slight inspection, more often they are obscure. Among the human agencies instrumental in this respect are the large fixed appliances of capture along the shores, a too persistent fishing by other means, dams built across the streams, preventing the ascent and descent of fishes, and the pollution of waters by factory refuse. The natural causes are less well defined, such as the failure of the food supply, the ravages of predaceous fishes and other animals, changes in temperature

and perhaps in density, poisoned waters, excess of sediment, unusual storms, accumulations of shore ice, diseases, etc.

The deterioration in the inshore fisheries of New England and in the shad, salmon, and whitefish fisheries appears to have been the result principally of human agencies; if not in all cases directly, yet through the destruction of the food on which the several species lived. The naturally poisoned waters of the Gulf of Mexico have caused much injury, and physical disturbances along the inner edge of the Gulf Stream have been known to practically exterminate an abundant species. The oyster-grounds of southern New England and New York suffer severely through the depredations of drills and starfishes, and epidemics of disease are not uncommon among the food-fishes of the interior lakes.

Precise methods of investigation are, therefore, necessary to determine the actual cause of decrease and to furnish the proper information on which remedial measures may be based. The character of these inquiries must vary with that of the fishing-grounds, and in accordance with the habits of the several species which are concerned. The remedies may be effected in two general ways—by legislation or by artificial propagation. A judicious protection of the grounds might in many cases be sufficient, but the laws hitherto enacted have not generally been very beneficial, owing partly to their inefficiency and partly to the careless manner in which they have been enforced. Fish-culture has, however, proved a very effective means for improving the condition of many depleted grounds, and its utility has long ceased to be problematical.

THE INCREASE AND DISSEMINATION OF FISHES.

The objects of fish-culture are, first, the maintenance or increase of existing fisheries, and second, the formation of new fisheries. The former relates chiefly to depleted grounds, the latter to grounds which have never been sufficiently productive. In order to carry out these purposes effectively the aid of science must be invoked, and its assistance is required in nearly every step taken. The actual operations of propagation, the collecting and hatching of the eggs, and the rearing and distribution of the embryos are dependent for their success upon the close observance of natural laws. It is essential to know the breeding habits of the species, the spawning places and seasons, the character and number of the eggs, the manner in which the latter can be fecundated and incubated artificially, the duration of the period of incubation, the developmental history of the embryo and the length of time it should be kept in captivity, the kind of food adapted to the young, and the proper localities for its planting, where it may find nourishment and freedom from its enemies.

In case the object of propagation is to replenish depleted grounds with a species native to them, the chief precaution to be taken is to

ascertain that the physical and, to a certain extent, the biological features of the region have not materially changed. The conditions of environment must remain congenial to the species, and it must have an abundance of proper food. If, on the other hand, fishes are being transplanted into new regions, it becomes necessary to study all the conditions of the latter with respect to their suitability for the forms in question. Are the temperature and density of the water and the character of the bottom adapted to them? Does the coast or river afford the necessary facilities for their spawning? Is there sufficient food for the young and adult, and is the region free from predaceous species which may destroy the eggs and embryos? Fishway methods, enabling the anadromous species to overcome obstructions to their ascent to spawning-grounds, must also be based upon scientific principles to insure their complete utility.

SPECIAL INVESTIGATIONS.

Among scientific problems which do not pertain directly to the above subjects, but which are sometimes of great importance, are such as relate to the deterioration of fishery products, methods of preservation of fish for food and bait, and the comparative value of the different species for food and other purposes.

FACILITIES FOR SCIENTIFIC INVESTIGATIONS.

The wide scope given to the scientific work makes it necessary to provide for a great diversity of observations. At the outset Prof. Baird found a steam launch and small sailboat entirely adequate to the conduct of his seacoast investigations. Two years later a naval tug was added to the fleet, and in 1877 this gave place to a larger naval vessel of the same type. With slight changes these two vessels were readily adapted to the explorations, and the experience acquired by their use led subsequently to the building of the fishery steamers *Fish Hawk* and *Albatross*. The schooner *Grampus* was afterwards constructed to meet certain requirements of the practical fisheries, but she is also fitted to participate in the study of scientific problems.

At present, therefore, the Fish Commission is provided with three vessels suited to the inquiries along the coast. The *Albatross* is a thoroughly sea-going steamer, built of iron, measuring 1,074 tons displacement, and propelled by twin screws. In her construction everything was sacrificed to strength and durability, to arrangements for easy working in a sea way, and to accommodations for scientific research. The heavy apparatus is operated from the forward deck, but the laboratories are amidship, being large and well equipped. Her outfit is the most perfect that has ever been supplied to any surveying vessel, and comprises every necessary device for sounding, dredging, and

fishing, as well as for physical observations, whether along the seacoasts or in the deepest parts of the ocean.

The steamer *Fish Hawk*, of 205 tons burden, was built when fish-cultural work along the coast was still regarded as experimental, and before the establishment of permanent hatching stations. She was designed, therefore, both as a floating hatchery and as a means for investigating fishery problems. To enable her to enter the shallow bays and river mouths in connection with the former service, her draft was made as light as possible, with a corresponding decrease in her seagoing qualities, but she is nevertheless well adapted for explorations, and her early trips to the offshore fishing-banks first demonstrated the expediency of having a steamer entirely suited to that class of work. The equipment of the *Fish Hawk* is similar in character to that provided on the *Albatross*, and equally efficient for use in shallow water. With the increase in number of hatching stations her services have been diverted more and more to the requirements of this division, and during the past year she has been largely occupied with the oyster and other scientific surveys.

The schooner *Grampus* is a modern fishing vessel of 83 tons burden, combining the best features of the American and English types. While serving primarily as a pattern for the improvement of the offshore fishing smacks, in which she has been entirely successful, she is also provided with the means of sounding and dredging in moderate depths of water, and of using all kinds of fishing apparatus. Her investigations have had reference chiefly to the migrations of the mackerel and to the conditions of the red-snapper banks in the Gulf of Mexico.

Facilities for special researches respecting the structure, life history, and habits of useful fishes and other kindred subjects are afforded by the several vessels, but more particularly by the large and well-equipped laboratory at the Wood's Holl Station, one of the most important of its character in the world. The aquaria at Washington also furnish the means for similar observations on a smaller scale, and temporary stations may readily be established anywhere along the seacoast or on the interior waters when such a course is necessary. The inland work, relating to the lakes and rivers, is at present chiefly carried on by temporary parties of volunteers, who make such observations as are possible in the field and conclude their examination of the specimens at convenient stations. The University of Indiana, at Bloomington, has been the headquarters for the surveys conducted under the direction of Dr. David S. Jordan, the remainder centering at Washington, where opportunities for investigations are provided by both the Fish Commission and the National Museum. The Commission is still dependent upon volunteers and temporary assistants for much of its scientific work, but it is hoped that the means for employing a larger permanent staff may soon be furnished.

THE PACIFIC COAST.

The development of the ocean fishing-grounds along the Pacific coast of the United States was taken up for the first time during the past year, the work being vigorously prosecuted and yielding results of great importance. The surveys were made by the steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding, and while the methods of inquiry were essentially the same that had been followed on the Atlantic coast, the operations were restricted chiefly to obtaining information of direct utility to the fishermen. The only extensive fishery investigations previously made in that region were conducted during the years 1879 and 1880, in connection with the fishery census, by Dr. T. H. Bean, for Alaska, and by Dr. David S. Jordan and Prof. Charles H. Gilbert, for Washington, Oregon, and California. Dr. Bean accompanied an expedition of the Coast Survey, and his personal observations were limited by the movements of the vessel and by the lack of proper facilities for offshore examinations. The inquiries of Profs. Jordan and Gilbert were principally confined to the use of seines along the shores and to the material obtainable from the small fishing boats and the local markets. However, the work of both these parties was performed in a most careful and painstaking manner, and the results accomplished were of great interest and value, especially as regards the inshore resources and the fisheries then existing. A full account of their discoveries and observations will be found in "The Fisheries and Fishery Industries of the United States," published by the U. S. Fish Commission between 1884 and 1887.

Respecting the region which he examined, Dr. Jordan explains that, "except the salmon fisheries of the Sacramento and the Columbia and the ocean fisheries in the immediate neighborhood of San Francisco, the fisheries of the Pacific coast exist only as possibilities; for the most part only shore fishing on the smallest scale is done, and no attempt is made to discover offshore banks or to develop them when discovered." He refers, however, to an extensive halibut bank, about 8 miles northwest of Cape Flattery, off the mouth of the Straits of Fuca, where the Indians take halibut in large numbers, and which, he adds, may sometime become of importance to the white people.

Dr. Bean's report contains a detailed summary of all that was known at the time of his visit concerning the fishing-grounds, the fishes, and fisheries of Alaska, except those for the marine mammalia, his information being drawn in part from the publications of Dall, Davidson, and other Alaskan explorers. After describing the inshore cod-fishing grounds occurring along certain portions of the coast, he states that "extended areas of soundings on which cod assemble in great masses are present in the Gulf of Alaska, but they have been but little investigated, and their limits and characteristics are imperfectly known." Four offshore banks are cited by name—Portlock, Shumagin, Sannak,

and Davidson—but they had been located by only a few isolated soundings, and their extent and boundaries were undetermined.

The only commercial marine fisheries which have been developed in Alaskan waters are those for the cod, and for the seal and other aquatic mammals. The first cod brought to San Francisco from the North Pacific region were said to have been taken in 1863 in the Gulf of Tartary and in the Ochotsk Sea. Two years later six vessels were engaged in this fishery, and in the same year they began to fish for cod in the neighborhood of the Shumagin Islands, off the Alaskan coast. Twenty-four vessels participated in this industry in 1870, but only eight in 1880, and the same number in 1888. The places most frequented for this purpose were in the vicinity of the Shumagin Islands and Kadiak, a few vessels also entering Bristol Bay to the north of the peninsula. Besides the cod, many other valuable food-fishes, including the halibut, are very abundant on the Alaskan coast; but owing to the distance from markets and the unsettled condition of the region these resources have not been utilized hitherto except by the natives. Even on the coasts of Washington, Oregon and California, where a great variety and abundance of marine fishes exist, the difficulty of disposing of a large catch has been the chief cause of the slow development of the fishing-grounds. The Alaskan products are chiefly marketed through San Francisco, which has also been the center of the only extensive local sea-fishery on the western coast. With the recent completion of several transcontinental railroads, affording the means of rapid transportation for fresh produce into the interior of the country, and with the prospect of greatly increasing the trade in salt cod and other prepared fishes with Central and South America, as well as Asia, a renewed interest has sprung up in relation to the western fisheries, which seems destined before long to exert a marked influence upon the welfare of the Pacific States. It was an expression of this interest that led Prof. Baird, shortly before his death, to prepare for the extensive investigations now in progress, which should determine, for the benefit of the fishermen, the varieties of fishes distributed along the coast, and the places where they occur in greatest abundance.

The steamer *Albatross* arrived at San Francisco from the Atlantic coast in May, 1888, at which time the general scheme of operations had been perfected by Commissioner McDonald. This provided primarily for a somewhat rapid yet comprehensive survey of all the waters adjacent to the western coast of the United States from the Mexican boundary line to the northern part of Bering Sea, the same to be restricted mainly to the submerged continental platform or between the shore line and a depth of 200 to 300 fathoms, as the principal bottom fisheries occur within those limits. As the characteristics of the bottom in this region are but little known, it was necessary to arrange for a very complete hydrographic as well as natural-history investigation, for both of which the *Albatross* is well adapted. Subsequently it is

proposed to engage in the study of special subjects, and, by careful observations upon the more important fishes, to collect data which can be utilized in the development of individual fisheries. Owing to the diversity of climate resulting from the great extent of coast line, the field work can be kept up during nearly the entire year and, therefore, with little loss of time.

A month and a half were spent at San Francisco in preparation for the first cruise, and on July 4, 1888, the *Albatross* started north, under instructions to explore the region south of the Alaska Peninsula between Unalaska and Middleton Islands. Completing this survey the last of August, she arrived at Seattle September 6, and continued operations on the coasts of Washington and Oregon, returning to San Francisco October 21. The winter cruise began January 3, 1889, the field of work lying between Point Conception and the Mexican boundary line, a trip also being made to the upper part of the Gulf of California for the purpose of determining the relations of that body of water to the Colorado River. The *Albatross* was back in San Francisco on April 25, but left again on May 21 to renew the investigations on the coasts of Washington and Oregon, which were still in progress at the close of the fiscal year. No fishery explorations were ever started under more auspicious circumstances, and none have been productive of more thoroughly practical results. For the successful execution of these plans credit is chiefly due to Lieut. Commander Tanner, who, with a full appreciation of the objects of the survey, has pressed the work with all his customary zeal and energy. Mr. Charles H. Townsend, an experienced collector, acted as permanent naturalist, and fishery matters were in charge of Mr. A. B. Alexander, formerly of the schooner *Grampus*. During the winter Prof. Charles H. Gilbert, of the University of Indiana, also joined the steamer as chief naturalist and ichthyologist. A narrative account of the year's operations is published in Appendix 4 to this volume (pp. 395–512), while the summer's cruise has been described in the Fish Commission Bulletin for 1888, pp. 1–95. The principal results may be summarized as follows:

ALASKA.

While approaching the Alaskan coast, soundings were begun in a depth of 2,550 fathoms, latitude 52° 15′ N., longitude 156° 37′ W., and were continued thence to Kiliuluk Bay on the south side of Unalaska Island. From this point the investigations were carried northeastward parallel with the coast line as far as Middleton Island, the most time being spent in those localities where banks had been reported by the fishermen, or where their existence was conjectured from other evidence. The results in a general way indicate that the entire submerged plateau in this region is one immense fishing-ground of irregular outline, not usually separated from the adjacent shores by deep water, but limited on the outer side by the abrupt slope beginning in about 100

fathoms. Although of much less extent, this important tract can best be compared with the eastern offshore banks extending from Massachusetts to Newfoundland, and, as with the latter, equally good fishing does not exist in all places, some localities being much more favorable in that respect than others. Whenever the ship was detained in port by stormy weather or for the purpose of coaling, attention was paid to inshore fishery matters.

Three lines of soundings were made off the south side of Unalaska Island, and while they were not sufficient to demonstrate the existence of a defined bank, it was estimated that an area of about 2,000 square miles in that region is suitable for fishing. The outlines and surface contours of Davidson Bank, discovered about 20 years ago by Prof. George Davidson, of the U. S. Coast Survey, were established with considerable accuracy. This bank lies south of Unimak Island, extending eastward from off the southern entrance to Unimak Pass as far as the shoal water surrounding Sannak Islands, and has an estimated area of 1,600 square miles. Sannak Bank lies to the east and southeast of the islands of the same name, and is elongate in shape, trending in a general way northeast and southwest. Its total extent is about 1,300 square miles. Between Sannak Bank and the Shumagin Islands, an area of about 1,800 square miles, more or less adapted to fishing, was partly surveyed, the depths ranging from 38 to 74 fathoms.

Directly to the south and southeast of the Shumagin Islands is an important bank, to which the same name has been given. Its outer margin was ascertained to follow approximately the trend of the coast line as formed by the adjacent islands, but its eastern limit was not determined. The part examined has a width of 15 to 35 miles and an area of about 1,800 square miles. Between there and Kadiak Island an extent of over 4,000 square miles was also partly developed, although not many fishing trials were made upon it.

Albatross Bank, named after the Fish Commission steamer, lies off the southeastern side of Kadiak Island, extending its entire length, and also in front of the Trinity Islands. Its eastern end is practically continuous with Portlock Bank, and its total area was found to be about 3,700 square miles, the 100-fathom curve being distant 25 to 45 miles from land. Portlock Bank is the largest single bank that has yet been discovered on the Alaskan coast, having an area inside of the 100-fathom curve of about 6,800 square miles, or only about 1,600 miles less than Georges Bank, the second in size in the western Atlantic Ocean. It extends northeastward from Kadiak Island in the direction of Middleton Island a distance of about 120 miles, and is very irregular in shape. From Portlock Bank the soundings were carried to Middleton Island, and thence to certain positions reported for the Pamplona Rocks, but without finding the latter.

The total area of the fishing-grounds on the Alaskan coast examined by the *Albatross* during this short season amounted to over 23,000

square geographical miles. The beam trawl and naturalist's dredge were frequently used upon all the banks for the purpose of determining the characteristics and conditions of the bottom as feeding-ground and its comparative richness in different places. The assemblage of animals collected strongly recalls the fauna of the great fishing-banks of eastern North America, and many of the species from both regions will probably prove to be identical. The more conspicuous features of the hauls were the fishes, crustaceans, mollusks, and echinoderms. Edible fishes, crabs, and shrimps were frequently taken, the last mentioned often in great numbers. The regular trials for fishes were made entirely with hand lines, cod and halibut being the principal species taken. Six to nine lines were generally used at each trial, which occupied from fifteen minutes to an hour or more, according to circumstances. Salt clams and salmon were chiefly employed as bait, and pollock, sculpins, and cod occasionally. The depths in which the fishing was done ranged from 27 to 84 fathoms, and every variety of bottom observed upon the banks was tried. A careful record was kept of the number of cod and halibut captured at each trial, and of their weight and size. The trials were usually made during the progress of, or subsequent to, a sounding or dredge haul, the steamer often drifting with the tide and changing its location before the hooks had touched bottom. The results were, therefore, not as satisfactory as they would have been had the steamer anchored and remained for some time in each position, as the fishermen consider that the large cod, as a rule, are the last to be attracted by the bait. In conducting lines of soundings, however, it is inexpedient to make long detentions, and it was regarded as most important that the hydrograpic work should be completed first.

The cod taken off Unalaska averaged from 21 to 28¾ inches in length; on Davidson Bank, 24½ to 28 inches; on Sannak Bank, 23½ to 25 inches; off Unga, one of the Shumagin Islands, 30 inches; on Shumagin Bank, 26½ inches; and near the Chirikoff Islands, 23⅘ inches. The best captures were made, however, on Albatross and Portlock banks. On the former, 47 cod, averaging 28½ inches, were caught in the space of thirty-eight minutes off Tugidak Island, and 69 cod, averaging 30¾ inches, in fifty minutes off Dangerous Cape. In a depth of 36 fathoms, on Portlock Bank, 30 cod, averaging 27 inches, were secured in eighteen minutes. The bait question presents no difficulties on the Alaskan coast, and the fishermen generally have no trouble in obtaining what they need during the progress of their work.

While the *Albatross* made no investigations in Bering Sea, sufficient information was obtained from the fishermen to prove the advisability of extending the inquiries into that region.

WASHINGTON AND OREGON.

Investigations were conducted along the coasts of these two States during September and October, 1888, and June, 1889. In May, 1889, the *Albatross* was placed at the disposition of the Senate Committee

on Relations with Canada, for the purpose of visiting southeastern Alaska, and, her services being accepted, arrangements were made accordingly. The steamer proceeded to Victoria, British Columbia, to meet the members of the committee, but a change in their plans becoming necessary, the trip was finally abandoned. The surveys off Washington and Oregon were at once taken up, however, where they had been stopped the previous fall, and were still in progress at the close of the year. During both seasons the operations were mainly restricted to the outer seacoast, although the inshore fisheries received due attention while the steamer was in port.

No soundings were made north of Cape Flattery, as the contour of the bottom at the mouth of the Straits of Fuca had previously been determined with sufficient accuracy for fishery purposes. The dredging and fishing appliances, however, were used in several places on the halibut bank described below. Hydrographic observations were carried southward from Cape Flattery, the bottom being uniform and consisting chiefly of gray sand as far as Gray's Harbor, off which place a small bank was discovered and surveyed. Rock-cod and other food-fishes were taken there in abundance, but no specimens of the true cod or halibut were secured. The coast of Oregon was examined as far south as Heceta Bank, the only distinctive offshore fishing-ground thus far detected in that region. A few fishing-spots occur along the shore, however, the most important one being adjacent to Tillamook Rock, a short distance south of the mouth of the Columbia River. Heceta Bank has a length of about 20 miles and a width of about 10 miles. The bottom is very uneven and supports an exceedingly rich growth of animal life, affording abundant food for fishes. Several varieties of rock-cod were very plentiful, and other valuable species were not uncommon, one small halibut also being captured there. The Tillamook Rock ground is only adapted to boat fishing, but in June four halibut were taken upon it, while an abundance of flounders, rock-cod, and other species were secured by means of the beam trawl, both in the vicinity of the rock and elsewhere along the coast. The investigations of the *Albatross* indicate, however, that the halibut fishery as a separate industry could not profitably be carried on in this region.

A halibut bank, resorted to by the Indians, begins close to the shore in the vicinity of Cape Flattery and extends thence northwestward about 15 miles with depths of 35 to 75 fathoms. Halibut are said to be abundant there from early in the spring until the middle of June, when the bank becomes infested with dogfish and sharks. The bottom is exceedingly variable and was found to be very rich in life. North of this bank as far as Barclay Sound, Vancouver Island, the bottom is smoother and less promising in every respect. A second halibut bank occurs off Flattery Rocks and extends in the direction of Cape Flattery, but it is smaller and much less important than the first. In the course of the fishing trials made by the *Albatross*, during the fall of 1888, it

became evident that the sharks and dogfish had taken possession of the grounds almost to the entire exclusion of edible fishes. On the principal bank halibut were taken in two localities, six specimens in all, averaging in one case 47¾ pounds each, and in the other 55 pounds each. Five halibut were secured north of this ground, but only one, weighing 140 pounds, on the bank off Flattery Rocks. In June, 1889, three days only were spent in this locality, and they were chiefly occupied with determining the contour of the outer edge of the larger bank. In one short trial with the trawl line eight halibut, averaging 35 pounds in weight, and several other food species were captured, dogfish being scarce. According to the testimony of fishermen who have recently operated in this region, halibut are abundant from March until into June, and vessel fishing may be considered advisable only between March 1 and September 1.

Beginning early in 1888, a number of trips for fresh halibut were made from different ports in the State of Washington. Some proved very successful, while on others poor fares were obtained or the vessels were absent a long time. Difficulties have also been encountered in the maintenance of this fishery through the competition of eastern markets, the cost of transportation, and the price of ice. The Gloucester schooner *Mollie Adams* secured its first fares of halibut on the bank off Cape Flattery, and the same vessel, fishing nineteen days off the southern extremity of the Queen Charlotte Islands, obtained 150,000 pounds of halibut, of which one-half were large enough for fletching. The crew shared about $9 apiece for each fishing day. The yacht *C. H. White* has made three trips to Flattery Bank since the fall of 1888, taking in all about 100,000 pounds of halibut, of which 60,000 were shipped fresh to New York, the remainder being smoked. The schooner *Rosie Olsen* took 15,000 pounds off Cape Scott, during a trip of about five weeks in the spring, while the schooner *Oscar and Hattie* had a long experience off the southeastern coast of Alaska and off British Columbia, lasting from January to June, 1889, a fare of 140,000 pounds, the fish averaging 65 pounds in weight, being finally secured.

SOUTHERN CALIFORNIA.

The examination of this region between Point Conception and the Mexican boundary line occupied the months of January and February, 1889. Some of the best fishing-grounds adjacent to the western coast were found in this district, and only the lack of markets prevents their immediate development. The continental plateau is wider here than to the north of Point Conception, and the area available for fishing is therefore much greater. Moreover several large islands, the Santa Barbara group, San Nicolas, Santa Catalina, and San Clemente are located near the coast, affording good anchorage and protection against storms. Two small but important banks, called Cortez and Tanner

banks, also exist directly off San Diego, at a distance of about 97 miles; the former has been known to navigators for a long time, but the latter was first discovered by the *Albatross*. Cortez Bank was found to be the most promising fishing-ground south of San Francisco; it has an area of 51 square miles with depths less than 50 fathoms, but good fishing can also be obtained in the slightly deeper water surrounding it on all sides. Many varieties of fishes were taken on the lines, the most abundant being several species of the rock-cod (*Sebastodes*), fat-heads (*Trochocopus pulcher*), sea bass (*Serranus clathratus*), and whitefish (*Caulolatilus princeps*). Tanner Bank is separated from Cortez Bank by depths of 150 to 250 fathoms, and has a shoal area about 17 square miles in extent. The fishes are identical on the two banks.

Lines of observing stations were run over the entire region, and all suitable localities were carefully tested with the fishing apparatus. The methods of existing fisheries were also studied, and much information was obtained respecting the habits and distribution of the food-fishes. The range of the black-cod or beshow, so abundant on the coast of Washington and farther north, was found to extend as far as the Santa Barbara Channel, where several specimens were secured by means both of hand lines and of the beam trawl.

GULF OF CALIFORNIA AND LOWER CALIFORNIA.

The *Albatross* left San Diego for the Gulf of California February 26, but taking advantage of the opportunity to examine certain reported dangers to navigation off the coast of Lower California, the cruise was not made direct. A line of soundings was carried first to the island of Guadeloupe, and thence to the Alijos Rocks, in latitude 24° 58′ N., longitude 115° 52′ 36″ W., and to the Revillagigedo group, of which Clarion, Socorro, and San Benedicto islands were visited in the order named. Besides obtaining very satisfactory hydrographic results, important collections of fishes and other marine animals were made. The investigations in the Gulf, beginning at La Paz, were carried northward to the mouth of the Colorado River, touching at San Josef Island, Carmen Island, Conception Bay, Guaymas, and other places. On the return trip the steamer again stopped at Guaymas and La Paz. The shallow waters at the mouth of the Colorado River were found to be very barren of life, and the conditions generally seemed unfavorable to the stocking of that river with the shad or other anadromous species.

While in the neighborhood of Guaymas an examination was made of the extensive oyster beds at the mouth of the Yaqui River. Oysters from this locality were formerly sent to the San Francisco market, and their introduction for stocking purposes into the bays of southern California has been suggested. The tropical conditions which seem necessary to their welfare, however, precludes their being used successfully for that purpose.

During the year the *Albatross* was at sea 168 days, the distance traversed during that time being 17,124.6 nautical miles. The total number of soundings made was 965, and of dredgings and trawlings 237. This record is much higher than for any previous year.

INTRODUCTION OF OYSTERS.

The native oyster of the Pacific coast is inferior in quality, and efforts have been made to introduce the eastern species, but as regards the establishment of self-sustaining beds it is reported that they have been entirely unsuccessful. Large quantities of the Atlantic oyster are carried overland and planted in San Francisco Bay, where they grow and remain in good condition for the market, but they are said not to reproduce to an appreciable extent, owing, it has been supposed, to the low temperature of the water during the breeding season. The study of the oyster problem on the western coast has been taken up by the Fish Commission during the past year, and while it has not the means to place a special party in the field for that purpose, the naturalists of the steamer *Albatross* have been instructed to make suitable observations whenever possible. Several opportunities occurred during last winter, and the facts obtained were presented in a report by Prof. Charles H. Gilbert, published in the Fish Commission Bulletin for 1889, pages 95–98.

According to Prof. Gilbert, the coast of southern California contains few harbors or river mouths which might prove suitable for oyster-culture. The proximity of the Coast Range of mountains and the limited rainfall conspire to produce small rivers, which are dry during the greater part of the year, and at other times commonly reach the sea by filtering through the sands thrown up across their mouths. Two of the most promising estuaries, Alamitos Bay and Newport Bay, were examined by Prof. Gilbert, and their characteristics are described in his report. The only other localities in the southern part of the State which might offer favorable conditions are Anaheim Bay and the mouth of Los Bolsos Creek, between Alamitos and Newport bays, and False Bay, near San Diego. All of these areas are very small, however, and observations during the dry season are required before reaching definite conclusions. The oyster beds near Guaymas, referred to above, are also discussed by Prof. Gilbert, who concludes that the Mexican oyster, living naturally under tropical conditions, is unsuited to the coast of California. It is proposed during the ensuing year to begin an investigation of San Francisco Bay with respect to its adaptability for oyster-raising.

TRANSPLANTING OF LOBSTERS.

Two large shipments of lobsters have been made to the Pacific coast within the past thirteen months, the plants being distributed between Monterey Bay and the Straits of Fuca, a distance of 11 degrees of latitude,

in order that the experiment might have the benefit of as wide a range of temperature and conditions as possible. The specimens were brought from the southern New England coast, where the water temperature, although much less equable, coincides in part with that of northern California. This subject is fully discussed under the special heading of "Lobster."

THE GULF OF MEXICO.

The red-snapper banks.—The red-snapper and grouper fisheries of the Gulf of Mexico were first investigated for the Fish Commission in 1880 by the late Silas Stearns, of Pensacola, Florida, whose report upon that subject was printed in the "Fisheries and Fishery Industries of the United States." Chart No. 16 of Section III of that publication represents the distribution of the fishing-grounds for those species between the mouth of the Mississippi River and the southern extremity of Florida. Most of the submerged continental platform along that portion of the coast, in depths less than 50 fathoms, was designated by Mr. Stearns as a more or less continuous fishing-bank, of which the principal commercial resources are the red snapper (*Lutjanus blackfordi*), red grouper (*Epinephelus morio*), and black grouper (*Epinephelus nigritus*). Although dependent upon the fishing vessels for the means of making his observations, he was able to describe the grounds in considerable detail, and to designate the general distribution of their commoner inhabitants. On the more southern grounds, he states, the majority of the edible fishes taken are groupers, while on the northern ones red snappers are more numerous and the groupers less common.

During the early part of 1885 the steamer *Albatross* made extensive explorations in the eastern part of the Gulf of Mexico, the fishing-grounds and fisheries examined being discussed by Capt. J. W. Collins in the annual report of the Fish Commission for the same year. With respect to the red-snapper banks, Capt. Collins explains that the grounds then generally visited in winter are embraced in a somewhat narrow belt along what is termed the outer edge of the shore soundings between the meridians of Cape San Blas and Mobile. So far as is known, the red snapper during the winter occurs in greater abundance along this stretch of bottom than elsewhere. The grounds lying between Cape San Blas and the Tortugas have been thoroughly worked over by the Key West smackmen, chiefly in depths of 5 to 15 fathoms, but outside of the 15-fathom line little fishing has probably been done south of Tampa Bay. The red snapper may, however, occur there in abundance, and should that fact be established this region would undoubtedly be resorted to whenever the supply diminished on the grounds nearest the fishing ports.

With the object of determining the characteristics and resources of the southern deep-water extension of this large bank, and bringing the same to the attention of the fishermen, the schooner *Grampus*, Capt. A.

C. Adams commanding, was dispatched to the west coast of Florida, leaving Wood's Holl, Mass., January 14, 1889, and reaching Key West on the 27th of the same month. Mr. W. C. Kendall acted as naturalist on the schooner, while Dr. James A. Henshall, secretary of the Cincinnati Society of Natural History, was detailed to make an investigation of the adjacent shores, as explained farther on. The work was conducted in a thorough and systematic manner and upon a somewhat different plan from any previous survey. The examination was begun about 20 miles north of the Tortugas Islands, with instructions to carry it as far northward as the time would permit, between the depths of 15 and 50 fathoms, or outside of the area now resorted to for fishing purposes. The bank in this region has practically a north and south trend and it was deemed most advantageous to run east and west lines of observations entirely across it, at regular intervals of 10 miles. Dredgings to determine the character of the bottom were to be made 10 miles apart on each line, while the fishing trials with hand lines were to be continued with as few interruptions as possible both while under way and while at anchor. The first line was started February 14, and the work closed March 27. Unfortunately, stormy weather prevailed during most of the season and prevented the extension of the survey north of the latitude of Charlotte Harbor, a distance of 100 miles from the starting-point. The instructions, however, were closely followed, and ten lines, averaging about 65 miles each in length, were run, the total area covered being, therefore, about 6,500 square miles. Had the time and weather permitted, the good fishing-places could have been more accurately located and their limits better defined, but as it is the results are interesting and instructive, the relative abundance and distribution of the several species having been ascertained with sufficient accuracy for all immediate purposes. It would, however, be important to determine to what extent these conditions vary with the seasons.

Three times as many red snappers as groupers were secured over the entire area, indicating that the former species is the most abundant one during at least the season when the inquiry was conducted. Red snappers were found in all depths from 15 to 48 fathoms, but the largest catches were made in depths of 15 to 25 fathoms, comparatively few being taken in over 30 fathoms. The red grouper ranged through depths of 15 to 37 fathoms, and the black grouper through depths of 19½ to 48 fathoms. On the more southern lines the red snappers and both species of groupers were found as far out as depths of 35 to 40 fathoms, becoming less abundant but increasing in size as the water deepened. As the work progressed northward, the fish were chiefly obtained on the inner parts of the lines, the red groupers also taking the place of the red snappers, which were rarely seen. In the deeper waters the black groupers predominated over the red groupers, the latter becoming relatively more common as the water shoaled toward the coast.

A detailed account of these investigations will be found in the Bulletin of the Fish Commission for 1889 (pp. 289-312), which also contains lists of the fishes, mollusks, and higher crustaceans collected during the cruise. It had been intended to extend the inquiry to Campeche Bank, where it is expected important fisheries can be established, but for reasons previously explained this matter was necessarily deferred until some future occasion.

Fishes of southern Florida.—The examination of the coast waters of southern Florida by Dr. Henshall, previously referred to, was carried on while the schooner *Grampus* was at work upon the offshore grounds. The object of his inquiry was to collect and study the fishes and other marine animals between Biscayne Bay and Tampa, paying particular attention to the abundance, distribution, and habits of those species which are of economic importance. He was provided with a seine boat and a dory belonging to the *Grampus*, together with the necessary fishing and camping equipment, and was accompanied by a local pilot and a seaman and cabin boy from the schooner. The party was conveyed by the *Grampus* as far as Indian Key on February 11, thence making its way through the reefs to Card Sound. From this point Dr. Henshall worked along the coast to Charlotte Harbor and Tampa Bay, concluding the investigation on April 4. Nearly all the work was limited to salt water, on account of the remoteness of the fresh-water streams from the shores and their inaccessibility, but a few isolated fresh-water ponds were reached by carrying the collecting outfit overland. Between Biscayne Bay and Charlotte Harbor practically no fisheries are carried on. From Cape Sable to Pavilion Key the coast consists of mangrove shores and islands, unsuited to the hauling of large seines. There is a small fishing ranch on Estero Bay, just below Charlotte Harbor, and at Gordon Pass and Marco a little fishing is done to supply the local demand, but at none of these places is the catch sufficient to entitle it to recognition from a commercial standpoint. In his report on the results of the exploration* Dr. Henshall gives a complete list of all the fishes collected, with notes upon their habits, distribution, abundance, and uses.

Propagation of the mullet and other fishes.—The steamer *Fish Hawk* left Washington January 6, 1889, to investigate the hatching of the mullet and of other fishes on the west coast of Florida. A few stops were made along the Atlantic coast, on the way south, in order to gather information regarding certain fisheries, and a brief examination was also made of the Blackfish Banks off Cape Fear, North Carolina. Reaching Charlotte Harbor, February 7, operations were immediately begun at that place and were subsequently continued at Boca Grande and Punta Rassa until about April 1. The spawning season of the mullet in this region had closed before the arrival of the *Fish Hawk*, but large numbers of the adults and of the fry were obtained in both fresh

---

*Bulletin of the U. S. Fish Commission for 1889, pp. 371-389.

and brackish water, the latter, measuring from half an inch to 3 inches long, having been found especially abundant in the headwaters of Alligator River, which are entirely fresh. According to the information collected, spawn might be secured in Charlotte Harbor and San Carlos Bay through a long period, beginning in September and continuing until early in January, but it was ascertained that the mullets have not decreased on the west coast of Florida to the same extent as along the south Atlantic coast. Lieut. Platt recommends as a site for a hatching station a place near Sinnable Point, in San Carlos Bay, about a quarter of a mile from the light-house. There is a good wharf belonging to the Light-House Service in that locality, and a steamer leaves there every alternate day for the railroad terminus at Punta Gorda.

Sheepshead (*Archosargus probatocephalus*) with ripe spawn were first taken by the *Fish Hawk* March 19, at the entrance to Charlotte Harbor, about 2,000,000 eggs being secured from 10 females and being impregnated with the milt of 4 males. Subsequently over 20,000,000 more of the same eggs were obtained. They are transparent, buoyant and very small, numbering about 50,000 to the fluid ounce. The tidal hatching box answered satisfactorily for their incubation, which requires from thirty-six to forty hours. The embryos can be planted when from seventy-two to eighty hours old; they are small, but hardy and active. The spawning fish can best be taken just before sundown, as the flood tide begins to make. They swim in schools, but not near the surface, and the seine would sometimes contain more than could be landed.

Of the spotted weakfish (*Cynoscion maculatum*) about 1,450,000 eggs were obtained, April 1, from 4 females and were impregnated with the milt from 4 males. The eggs are said to be of about the same size as those of the sheepshead and are also buoyant, hatching in about forty hours. About 350,000 healthy embryos were obtained from the above lot. Large numbers of pompano and Spanish mackerel were captured at different times. The former were not in spawn, but in the latter the roe seemed to be somewhat advanced.

THE ATLANTIC COAST.

During the past year the general exploration of the fishing-grounds, hitherto the most prominent feature of the work along the Atlantic coast, was discontinued in that region, as explained above, and in its place special investigations relating chiefly to the oyster fishery were taken up. The latter industry is greatly in need of such assistance as might be afforded by careful study and experiment, and the time seems opportune for utilizing in that direction the information which has been collected during the past eighteen years. The oyster (*Ostrea virginica*) is native to all parts of both the Atlantic and Gulf coasts of the United States, and small colonies occur even as far north as the Gulf of St. Lawrence. Only a few small natural beds now exist, however, in waters

tributary to the Gulf of Maine, and the fishery first becomes important on the southern New England coast, where the beds have been greatly enlarged by the planting of both native and Southern seed. New York has shared with Connecticut in the impetus recently given to this ready system of oyster-culture; in New Jersey the fishery is extensive, and in Maryland and Virginia the natural resources have afforded advantages superior to those of any other States. Farther south, however, while important fisheries exist in some localities, the industry may be said still to await development. The natural conditions are favorable nearly everywhere, and the thick growths of "coon" or wild oysters, forming a broad fringe along the coast, constitute a supply of seed which appears to be inexhaustible.

In spite of the great prosperity of the oyster fishery at the north, resulting from the recent enactment of judicious laws, it has certain serious drawbacks, which tend to reduce the profits and threaten to some extent its future welfare. In the salt waters of New England and New York the drills and starfish are most persistent and destructive enemies of the oyster, doing an amount of damage to the beds which it is difficult to calculate. Enemies of this character give practically little trouble in Chesapeake Bay, but under the present system of administering upon the fishery there the production of the grounds is rapidly falling off from year to year, sufficient inducements not being offered to supplement the natural supply by the artificial extension of the beds. Oyster-culture, properly so called, the production of spat by aid of artificial methods, has, moreover, never been resorted to in this country, in consequence of the fact that the practical utility and economy of any proposed system has yet to be established. As the scarcity of seed is one of the greatest difficulties now encountered by the oyster-planter, this subject offers an interesting field for investigation.

The above statements plainly indicate in what channels the inquiry may be directed to best advantage for the oyster fishery. The oystermen of New England and New York desire to learn by what means, if any, their beds may be preserved from the attacks of drills and starfishes; in the Chesapeake, the wisdom of some system of individual responsibility for the condition and abundance of the crop must be demonstrated practically; in more southern waters, the best manner of utilizing the wild stock should be determined and a system of oyster-culture applicable to all parts of the coast should be developed.

For the prosecution of these inquiries the several States have looked to the General Government as being the best equipped for that purpose, and also in view of the fact that the questions at issue are not limited in their application to any one State. Experiments respecting oyster-culture were conducted by the Fish Commission in Chesapeake Bay during several years, but they were temporarily discontinued before a final solution of the matter had been reached. Outside of these researches and the methods and statistics of the business, the Fish Com-

mission has paid but little attention to the oyster question, its limited resources for investigation being utilized for the benefit of other fisheries whose demands seemed more urgent. The present Commissioner, however, has considered it expedient to begin at once upon the study of this subject, applying to it such means as are now available, special provisions not having been made by Congress for this branch of work. The steamer *Fish Hawk* is well adapted to this inquiry, but being also required for certain fish-cultural operations she is available during only a few months of each year, and considering the great extent of seacoast to be covered, her progress must necessarily be slow. It was not until September, 1888, that she could be detailed for this purpose, the two months remaining, suitable for investigation, being spent upon the southern New England coast.

While the oyster beds in this region are subject to injury from several causes, by far the greatest amount of damage is effected by the drills and starfishes, and these two animals, harmless as they appear, are particularly dreaded by the oyster-planters. The former, a small gastropod or snail-shaped mollusk, whose mouth is provided with a ribbon-like tongue, armed with several rows of minute but relatively strong and very sharp teeth, pierces the upper valve with a small hole, through which the soft parts are subsequently extracted. It feeds principally upon the young oysters, preferring those from a few weeks to a few months old, in which the shell is still thin and quickly bored. It is also most abundant in shallow water, and comparatively few individuals are capable of doing widespread damage. The starfish is more widely distributed as regards the depth of water and, often attaining a comparatively large size, is not limited in its diet to the smaller oysters. Placing its five arms about the shell and extruding its capacious stomach, it causes the two valves to open and, without appreciable injury to the stony covering, absorbs the inclosed tissues. These two enemies, however unwelcome they may be, are natural associates of the oyster, finding congenial to them the same temperatures and the same densities of water which prevail in that region. Here they reproduce and complete their life history. Whatever privileges the one enjoys, the others are equally entitled to by nature, and this circumstance renders the question of protection an especially difficult and perplexing one. While the drill and starfish do not confine their depredations to the oyster, the latter seems to be their particular favorite, and with the enlargement of the beds by planting, the number of these two pests appears to increase proportionally. The oystermen have no other remedy than the forcible removal of these animals after the grounds have been invaded, generally necessitating the taking up of many of the oysters with them and often the entire stock. Special dredges and tangles have been devised for the capture of the starfishes, but none of these have proved of much utility.

Considering the amount of damage done by the drills and starfishes,

and the cost of their removal, usually not until a large percentage of the crop has been destroyed, it may be realized with what anxiety the oystermen regard their presence and how desirous they have become to ascertain if any precautions can be taken to anticipate and prevent their inroads. However impracticable this question may appear from our present knowledge of the habits of those species, the matter is sufficiently important to warrant its careful study, and even should the inquiry not prove entirely satisfactory in that respect, it will undoubtedly lead to other improvements in the oyster fishery of that region. The scheme of work proposed has been prepared upon a basis broad enough to meet all the present requirements of the industry.

Mate James A. Smith, U. S. N., commanding the steamer *Fish Hawk*, was in charge of operations during 1888, with Mr. C. F. Hodge, of Johns Hopkins University, as naturalist. A visit was first made to New Haven, to enable Mr. Smith to confer with the shellfish commissioners of Connecticut and the oyster-growers in that vicinity, after which a month was spent in Narragansett Bay and Providence River, the steamer returning to New Haven later in the season for a brief reconnaissance.

The plans for the investigation of Rhode Island waters contemplated a thorough survey of the upper part of Narragansett Bay and of all of Providence River as far up as the city of Providence, and provided for the following character of inquiries, namely: An examination respecting the physical characteristics and condition of the bottom and of the water, with density and temperature observations at many places during different stages of the tide; a systematic series of dredgings to determine the present condition of the oyster beds, the distribution and abundance of drills and starfishes, and the character and extent of the damage they are doing; the plotting of the principal existing oyster beds on charts, and a comparison of the same with the beds known in 1880, in order to ascertain if any and what changes have taken place between those dates, and their probable causes; a study of the life history and habits of the starfishes in this region, the latter with special reference to their movements and distribution at different seasons of the year; conferences with the oystermen respecting all matters pertaining to the damage done the beds by their natural enemies at different periods and the means taken to remove the latter or to protect the beds. As no scientific examination of this region had previously been made, and no information was obtainable as a basis for comparison, the difficulty of reaching positive conclusions in the course of a single season's operations was soon made evident. The oyster beds were last chartered by the State shellfish commission in 1880, their delineation furnishing the positions and outlines of the grounds, but nothing regarding their conditions at that time.

The *Fish Hawk* began the investigation by running a line of density observations through the main channel of Narragansett Bay from off

Brenton's Reef light-ship to a point opposite the north end of Prudence Island, which demonstrated that at this season of the year the salinity of the water in this passageway continued nearly uniform at all times of the tide. Between the North Point of Prudence Island and the mouth of Providence River, the examination was made in much greater detail and showed that while at the bottom the densities varied only slightly with the tides, at the surface the changes are more perceptible. Within this area the bottom is mostly covered with a thick layer of mud; no natural oyster beds exist, but a planted bed of about 8 acres in extent is located to the south of Conimicut Point. Starfishes were found to be abundant on a small mussel bed lying to the south of Nayat Point, but only a few were taken in the dredgings elsewhere.

Plottings were made of the larger and more productive beds in Providence River, the same being based upon the surveys of the *Fish Hawk*, with additional information furnished by the oystermen. A comparison of this work with the State oyster map of 1880 shows that a large area of oyster bottom has been abandoned within the past eight years, but its extent was not determined. The set of spat, moreover, was inconsiderable during that period, and the planters have been obliged to obtain their seed chiefly from Connecticut and other waters. The oysters raised about Bullock Point and in its vicinity are considered the finest in the river. The beds nearest the river channel suffer more or less from the depredations of starfishes, which do not reach the inner beds, the latter, however, being subject to the attacks of drills and periwinkles. Off Sabine Point there is also a good oyster bed, which is not troubled by starfishes except to a very slight extent along its outer edge. Great Bed, so called, was once regarded as one of the best pieces of oyster bottom in the river, but since the freshet of 1886, when it was covered with mud, it has greatly deteriorated, and most of the leases have been canceled. A few small patches of oysters occur between Gaspe Point and Pawtuxent Beach, but drills and periwinkles are so abundant upon them and have been so destructive that the present owners propose to relinquish their claims. The *Fish Hawk* found starfishes most plentiful on a bed of 100 acres just to the north of Nayat Point, where, it was estimated, they had already destroyed about one half of its crop of two-year-old oysters. The greatest amount of damage observed, however, had been done by the drills. The beds about Field's Point and in Bullock's Cove, formerly said to have been the most productive in the river, were in a very bad condition, due to their inroads. Large quantities of oyster shells, one, two, and three years old, with scarcely a living specimen among them, were frequently brought up in the dredges. Over a large proportion of these grounds fully 95 per cent of the oysters had been killed in this manner. One owner estimates his loss of seed oysters during 1887 and 1888 at 40,000 bushels, worth 40 cents a bushel, his entire stock having practically been wiped out.

The observations made upon the distribution of starfishes as determined by the salinity of the water are not conclusive, owing to the fact that they were confined to a single month, during which there was a considerable rainfall, although the latter apparently had only a slight effect upon the bottom densities. According to the statements of the oystermen, the upper limit of the starfishes in Providence River is usually in the vicinity of Field's Point, but during seasons of prolonged drought they have been known to ascend as far as the Ohio bed, near the lower bridge at Providence. The mean density of the water at the bottom off Field's Point in September, 1888, was about 1.0187. Off Mobjack Bay, in the southern part of Chesapeake Bay, the average density in April, 1889, was about 1.015. As starfishes are rare, if not entirely absent, in the latter locality, well known for its oyster beds, it is possible that the lowest limit of density in which they can survive for any length of time may be found between the two figures given above.

That these animals might be driven out of Providence River by the freshening of its waters was demonstrated in 1886, but under conditions which proved nearly as destructive to the oysters, although the direct cause of the injury done to them was probably not the same. Starfishes had been very plentiful in 1885. In February, 1886, while the ground was coated with a frozen crust of snow, a heavy rainfull occurred over the drainage tributary to Providence River, producing an unusual freshet and bringing down large quantities of mud, which covered the beds on the west side of the river, and is said to have destroyed nearly the entire crop of oysters there. The starfishes disappeared at the same time throughout the entire river, because, it was supposed, of the great inroad of fresh water, and they did not again become abundant until the summer of 1888, after a lapse of a year and a half. Those observed at the mouth of the river by the *Fish Hawk*, in September, 1888, were of large and nearly uniform size, very few young ones being found among them.

Several means of protection have been suggested for Providence River, but none of them seem feasible. Inclosures in the way of screens about the beds, while they might exclude large objects, would not keep out the young starfishes and drills, and as both of these species remain in the river during the entire year, they would have to be constantly removed by the methods now in use. Furthermore, such barriers would be expensive and could not readily be made durable. Should the pond system of oyster-culture be introduced in this region, however, the trouble with enemies could be largely, if not entirely, overcome. Starfishes are known to have a great fondness for the common mussel (*Mytilus edulis*), and it has been considered that colonies of that species planted around the oyster beds might serve as a partial protection to the latter. Two extensive mussel beds are situated at the mouth of Providence River, one on either side of the narrow channel opposite the Nayat Point light-house, but, while a half bushel of starfishes were

taken from them on nearly every trial made with the large oyster tongs, they seemed to have little, if any, effect in shielding the neighboring oyster beds. Moreover, this method is said to have been tested unsuccessfully off Bridgeport, Conn. Under favorable conditions the mussels also grow very rankly, tending to displace the oysters and accumulating much mud about them as well as other unwholesome matters. Baited traps placed on and about the oyster beds have likewise been tried by the oystermen and by the Fish Commission, but they have not proved generally effective, although a certain measure of success has been reported from their use in some localities.

At New Haven a large map was prepared showing the location and extent of all the planted oyster beds in the harbor, and of the natural beds on the west side of the entrance. Density and temperature observations were also taken as in Providence River, but not so closely together.

Arrangements have been completed to begin upon the investigations in Long Island Sound during the summer of 1889, and they will subsequently be carried southward along the coast. Other inquiries pertaining to the Atlantic coast, conducted during the past year, are described under special headings.

INVESTIGATION OF INTERIOR WATERS.

The object of investigating the different lake and river systems of this country upon a broad and comprehensive basis has been explained in the preliminary remarks, but while the importance of such inquiries has all along been recognized, the subject received comparatively little attention from the Fish Commission until the present year, when it was taken up as an essential feature of the scientific work. The problems involved here, as in other branches of the field work, are of two classes, physical and biological, the latter being again divisible in conformity with popular classification, according to whether they relate to fishes, invertebrates, or plants.

The collection and study of the fishes may proceed with considerable rapidity, owing to their relatively large size and the convenient means devised for their capture both by naturalists and fishermen, but the physical questions, and more especially the aquatic invertebrates, represented by a countless number of varieties and composed in large part of almost microscopic forms, present far greater difficulties in the way of detailed observations, and will require a much greater length of time to secure appreciable results. Owing to the different nature of the field work called for by each of these branches, they must to a great extent be taken up and carried along independently of one another. No other method is generally expedient unless it is desired, by means of a reconnaissance, to obtain immediate information respecting the combined features of any particular region. A party, specially

equipped, need not, however, entirely limit its operations to a single subject, as has been shown by the experience of the past year, during which the fishermen obtained many important data respecting the character and conditions of the streams they visited. Fortunately the United States is well provided with competent ichthyologists, and many students are now in course of training in this popular branch of natural history. Physicists, however, have paid but little attention to the requirements of the fisheries, and few specialists have yet displayed an active interest in the lower organisms which inhabit our fresh waters. The ichthyologists are therefore best prepared to render prompt assistance, and many of them are so situated as to be able to give their services gratuitously during two or three months of each year. Without their liberal support very little could have been accomplished in this division of the inquiry, owing to the slender means available for the purpose.

Having determined upon the advisability of expanding the work in this direction, the Commissioner held a conference at Detroit, Mich., during May, 1888, with the commissioners of several States, who not only gave the project their approval, but urged that it be taken up without delay. Dr. David S. Jordan, president of the University of Indiana, but best known for his extensive studies on American fishes, was also present at the meeting and offered his hearty coöperation; under his able management a school of ichthyology has been founded at Bloomington, Ind., its graduates taking high rank for accurate and painstaking observations. A proposition made by him to organize temporary parties of volunteers from among his former pupils and those now studying under his direction was accepted by the Commissioner, and the work was started early in the fiscal year. Depending upon the services of students and professors occupied with college duties for eight or nine months of every year, the field excursions must be limited chiefly to the summer, but it is expected that some satisfactory arrangement will soon be possible whereby the inland investigations may be organized upon a permanent basis, and, in fact, one of the river explorations now in progress is being executed by regular employés of the Commission.

The plan of work adopted in regard to the volunteer service contemplates, first of all, the somewhat rapid investigation of those regions with which we are the least acquainted, in order to obtain, as soon as possible, a general, though not superficial, knowledge of all our fresh-water fishes, their varieties, distribution, abundance, and habits. Upon the completion of this survey, which may occupy three or four years, the more careful study of each lake and river system can be taken up. Of the inquiries conducted during the past year, as described below, all excepting those which relate to the Hudson River, the Upper Ohio River, and the Alaskan salmon rivers were planned and carried on under the direct supervision of Dr. Jordan, who also participated in the field work during most of the summer of 1888. The cost of these

expeditions amounted only to the actual field expenses of the assistants, while the reconnaissance of the Ohio River by Dr. Henshall and Prof. Gilbert involved no outlay whatsoever on the part of the Fish Commission. The collections made by Dr. Jordan's parties were sent directly to the University of Indiana, where they were studied and where the reports upon them were prepared. The first series of the specimens of fishes has been deposited in the U. S. National Museum at Washington, and the second series in the museum of the University of Indiana. Over 7,000 specimens, representing 141 species and subspecies, of which 14 were new to science, were obtained during the summer investigations in the Alleghany region. From this material 30 duplicate sets of fishes were made up, the same being donated to as many educational institutions, some located in the States where the work had been conducted, the others elsewhere in the United States and in Europe. The crayfishes, of which many specimens were secured in the different regions examined, have been referred to Prof. Walter Faxon, of the Museum of Comparative Zoölogy, Cambridge, Mass.

Dr. Jordan has already begun, with the coöperation of Prof. B. W. Evermann, a complete record of all that has so far been discovered respecting the fresh-water fishes of North America, which, when published, will serve as a basis for future explorations. Its completion will be delayed, however, until the preliminary surveys now in progress have been finished.

The States and Territories into which the investigations were extended during the year 1888–89 numbered eighteen and are as follows: New York, Virginia, West Virginia, North Carolina, South Carolina, Tennessee, Kentucky, Georgia, Alabama, Mississippi, Louisiana, Ohio, Indiana, Michigan, Iowa, Missouri, Arkansas, and Alaska. The work accomplished in each region is summarized below:

The Hudson River, New York.—That the Hudson River is not a natural salmon river is probably due in greater part to the fact that all localities suited to the spawning habits of the fish have been cut off from the main river by insurmountable obstructions. The first systematic attempt to stock the Hudson artificially by the planting of fry from the Penobscot River, of Maine, was begun in 1882 and has been continued down to date. In order to test the utility of these efforts an investigation of this river and of some of its tributary streams was made during the summer of 1888 by Mr. Fred. Mather, of the Cold Spring hatchery, New York, under the direction of the U. S. Fish Commissioner. The specific objects of this inquiry were to ascertain as nearly as possible the number of adult salmon (*Salmo salar*) caught in the Hudson River during the previous season; to determine the possibilities of taking salmon eggs on that river in sufficient numbers to warrant the establishment of a temporary station for that purpose; to examine the small streams with reference to their fitness for developing the young fish during their river life; and to learn the height and

character of the natural and artificial obstructions to the ascent of salmon.

Mr. Mather's report upon the results of his observations was published in the Bulletin of the U. S. Fish Commission, vol. VII, for 1887, pp. 409–424. In a preliminary statement he describes the plantings that were made from 1882 to 1888, inclusive, amounting to over 2,000,000 fry and 150 yearlings. These young fish were all liberated in good trout streams, chiefly in the Adirondack region of Essex and Warren counties, N. Y. Several adult salmon were taken in the Hudson River both in 1886 and 1887, some of which found their way to the markets of New York City. The salmon captured in 1888 could not have belonged to later plantings than those of 1884, up to which time only 864,600 fry had been placed in the river, and any comparison of results should be based upon that number. Mr. Mather experienced considerable difficulty in obtaining information respecting the catch of 1888, as a State law, passed in 1887, prohibits the taking of salmon on the Hudson River except with hook and line. Nearly all of the fish secured were captured incidentally in the nets of the shad fishermen, who were naturally reluctant to testify against themselves or against their neighbors. The inquiry, however, finally resulted in a record of 134 salmon so obtained, but Mr. Mather estimates that fully four times as many were probably taken by this class of fishermen alone. Of the number mentioned, 28 were caught in Gravesend Bay, 20 in New York Bay, 3 in Princess Bay, 5 along the New Jersey shore, and the remainder at points along the Hudson River as far up as Mechanicsville, 26 having been secured below the dam at Troy. The weight of these fish ranged from 5 to 26 pounds each, but very few weighed less than 8 or 9 pounds.

As to gathering salmon spawn in New York waters for use in stocking the Hudson River, the above record indicates that there are at present only two localities where the prospects are at all favorable for obtaining the necessary parent fish, namely, below the dam at Troy and in Gravesend Bay. Considering that these fish are taken rather early in the year, it would, however, be necessary to pen them until the spawning season, and the water of the Hudson River below Troy is apparently too warm for this purpose during the summer. Deep, cool spots exist between Troy and Mechanicsville, and also at the latter place, to which the fish collected in the upper part of the river could be transferred, while the hatching station at Cold Spring Harbor, Long Island, might be used as the depository for those captured in Gravesend and New York bays. The number of eggs to be secured in this way would probably not be sufficient, however, to warrant the expense attendant upon the work until salmon have become more abundant in the river.

All tributary streams suited to the spawning habits of salmon enter the upper part of the river, and the ascent of salmon to them is now

prevented by both natural and artificial obstructions. In case these obstructions are overcome by the building of fishways, there is every reason to suppose that the Hudson will in time become a natural salmon-producing river, a result which it is very desirable should be consummated. Preliminary steps in that direction have already been taken, and it is to be hoped that they will soon be followed by more active measures. The first impediment met by the fish in their movement up the river has been the State dam at Troy, but this has already been provided with a suitable fishway. The second obstruction is a dam at Mechanicsville, at the foot of which salmon were seen jumping in 1888. Above this place there are ten or more falls and dams, the uppermost being Rockwell Falls, at Lucerne, and the most formidable Palmer Falls and Dam, at Jessup Landing. Appropriations have been made by New York State for fishways over the Mechanicsville Dam and over the next one, at Fort Miller. Their construction will open up a continuous run to Fort Edward, 45 miles above Troy. Here there is an old dam which will soon have to be rebuilt, and in so doing a fishway will undoubtedly be added by the owners, a law obliging such construction now being under consideration by the State legislature. Next follow Baker and Palmer falls, both of which present many difficulties, but it is probable that they can be surmounted, if sufficient money is made available. It is probable, however, that with the river opened up to Fort Edward or Baker Falls, the salmon will find good spawning-grounds in some of the lower tributaries. Mr. Cheney, of Glens Falls, N. Y., is confident that such will be the case, and his wide acquaintance with the region in question entitles his views to every consideration. The following remarks upon this subject are abstracted from a letter written by him since the completion of Mr. Mather's survey:

The Moseskill comes in on the left bank of the Hudson about 5 miles below Fort Edward. Above and below it are smaller streams. Snookill, a good spawning stream running back 7 or 8 miles, comes in on the right bank below Moseskill. The Battenkill, or "Lovely Ondowa," is a good trout stream that runs up into Vermont; it comes in below Thompson's Mills. Below this is Hoosick River. I believe that when the salmon find that the State of New York has not provided a way for them over the falls, they will go into some or all of the streams above mentioned, and there spawn. I, for one, will feel quite easy about the salmon when the two fishways are built at Mechanicsville and Fort Miller. Without doubt, the salmon have spawned in the river below Mechanicsville, and many more ascended the dam at Troy than has generally been supposed. The adult salmon evidently tried to get up the Mohawk River, and spawned below Cohoes Falls.

From Mr. Mather's investigation it is, therefore, evident that the results of salmon planting in the Hudson River have been very satisfactory, and promise to repay the outlay of time and money which have been applied to it. With proper legislation, the removal of further barriers, and the added efforts of fish-culture, this important stream should eventually provide good salmon fishing upon a commercial scale.

The Alleghany region of Virginia, North and South Carolina, and Tennessee.—The investigation of this region was conducted personally by Dr. Jordan, with the assistance of Prof. O. P. Jenkins, of De Pauw College, Indiana; Prof. B. W. Evermann, of the State Normal School, Terre Haute, Ind.; and Prof. S. E. Meek, of Coe College, Iowa. Work was begun at Luray, Va., July 25, and continued until September 8, when high water in the rivers prevented further seining. The survey had reference to the two general river systems, one flowing into the Atlantic Ocean between Chesapeake Bay and the Santee River, the other into the Ohio River, and in many instances operations were continued down the river courses a considerable distance toward the coast.

The following rivers of the Atlantic drainage were examined, namely: The Shenandoah, a tributary of the Potomac River; the James River and several of its tributaries; the Dismal Swamp, Elizabeth River; the Blackwater, a tributary of the Chowan River; the Staunton, one of the main branches of the Roanoke River, in Montgomery and Roanoke counties, Virginia; the Tar River, a tributary of the Pamlico; the Neuse River and several of its tributaries; the Haw River, a tributary of the Cape Fear; the upper waters of Great Pedee River; the Santee River and many of its upper tributaries. In the Ohio River drainage, the streams examined were several tributaries of the Kanawha River in Virginia, of the Holston River in Virginia and Tennessee, and of the French Broad River in North Carolina. The total number of seining stations was 54.

The collections obtained were transmitted to the University of Indiana, where they were studied by Dr. Jordan, whose report upon the inquiry has been published in the Bulletin of the Fish Commission for 1888.* The limited time that could be given to the investigation, considering the wide area which it covered, prevented the party from paying attention to other subjects than the fishes, with some reference to the physical characteristics of the rivers. Dr. Jordan's paper is one of the most comprehensive and valuable contributions of its kind that has yet been published anywhere, and will prove of great interest both to fish-culturists and to the fishermen of the region which it describes. The subject is treated by river systems, and under each heading is given a brief account of the physical features of the main river and its tributaries as determined at the localities visited, followed by a list of the fishes taken, with notes upon their habits and special habitats. Several new and little-known species and varieties are also discussed at greater length. The new species were described in a preliminary paper which has been printed by the U. S. National Museum.†

---

*Report of explorations made during 1888 in the Alleghany region of Virginia, North Carolina, and Tennessee, and in Western Indiana, with an account of the fishes found in each of the river basins of those regions. By David Starr Jordan. Bull. U. S. Fish Commission, VIII, 1888, pp. 97–173, plates VIII–XV.

† Descriptions of fourteen new species of fresh-water fishes collected by the U. S. Fish Commission in the summer of 1888. By David Starr Jordan. Proc. U. S. National Museum, XI, 1888, pp. 351–362, plates XLIII–XLV.

The Upper Ohio River and its tributaries.—During August, 1888, Dr. James A. Henshall and Prof. Charles H. Gilbert, of Cincinnati, made an ichthyological reconnaissance of the Ohio River and its tributaries between Marietta and Cincinnati, Ohio, in the joint interests of the U. S. Fish Commission and the Cincinnati Society of Natural History. For the conduct of this exploration the Hon. Nicholas Longworth, of Cincinnati, placed his steam yacht *Minx*, with its crew of six men, at the disposal of Dr. Henshall, an act of liberality which was much appreciated. Rainy weather, causing unusually high water for the summer season, greatly interfered with operations and curtailed the anticipated results. The streams explored were the Ohio River at numerous places, the Muskingum, Little Miami, and Hocking rivers, and Raccoon, Brush, and White Oak creeks, in Ohio; the Kanawha and Guyandotte rivers, in West Virginia; and the Big and Little Sandy rivers and Kinnikinnik and Tygert creeks, in Kentucky. Nearly 100 species of fishes were obtained, a few of which had not previously been recorded from those waters.

The most abundant species observed in the Ohio River were the channel catfish (*Ictalurus punctatus*), red-horse (*Moxostoma*), buffalo (*Ictiobus*), carp sucker (*Carpiodes*), fresh-water drum (*Aplodinotus grunniens*), toothed herring (*Hyodon*), gizzard shad (*Dorosoma cepedianum*), and skipjack (*Clupea chrysochloris*). Pike perches or Ohio salmon (*Stizostedion*), newlights (*Pomoxis annularis*), black bass, chubs, and shiners were also common. The catfishes, suckers, buffaloes, red-horses, and white perch (drum) sell well in the markets, and appear to be esteemed as food in all the towns along the river; the pike perch (Ohio salmon) and the black bass rank highest among the river fishes, but are not caught in sufficient quantities to supply the demand. The fishermen have shanty boats at the mouths of all the smaller streams. They use fyke-nets, drag seines, and trot lines, and have no difficulty in selling all the fish they catch.

The Muskingum is a swift, beautiful stream, flowing through one of the most attractive and fertile valleys of Ohio. Its banks are well wooded with gigantic elms, maples, beeches, and sycamores. The river has a rocky bed with many rapids, but it is navigated for a hundred miles by means of locks. The party proceeded up the river some 60 miles, to within a short distance of McConnelsville, passing through six locks. They explored the main stream at the foot of the dam at each lock, and a few of the small tributaries. The young of the black bass and pike perch were quite abundant, showing that favorable results have attended the stocking of these streams by the Ohio Fish Commission. In the Kanawha River the red-horse, carp sucker, drum, and skipjack were again found to be the most abundant, with the pike perches, gars, and sunfishes less numerous. The waters of the Little Kanawha were so impregnated with petroleum that fish life seemed to

be entirely absent. In the Hocking, Raccoon, Brush, and White-oak creeks, in Ohio, were found the usual river minnows and darters, with the young of the larger river fishes, but the creek species were driven far up the streams by the unusually high water, and no favorable places for seining could be discovered. In the Big and Little Sandy, Kinnikinnik, and Tygert creeks, in Kentucky, newlights, black bass, pike perches, and sunfishes were quite abundant, as these streams have more fall and a swifter current than those on the Ohio side. In Little Miami River the trout perch (*Percopsis guttatus*) was common, as it was also in the Muskingum. Dr. Henshall thinks these are the first instances of its having been taken in southern Ohio, as it was hitherto supposed to be peculiar to the Great Lakes. It is possible that it has found its way to the Ohio basin through the canals.

Indiana.—Early in September, 1888, Prof. B. W. Evermann began the investigation of certain areas in western Indiana whose fishes had not previously been studied, continuing the work until cold weather interfered. He was assisted by Mr. C. H. Bollman and Mr. A. J. Woolman. The following rivers were examined: St. Joseph River, between Mishawaka and South Bend; Yellow River at Plymouth; Upper Wabash River, on several of its tributaries; Lower Wabash River and its tributaries; Lower Ohio River, near Evansville and Mount Vernon; and White River, at Spencer and Cataract. An account of the results of this inquiry has been included in Dr. Jordan's report on the Alleghany region of Virginia, etc., referred to above.

Michigan.—An examination of the lakes and rivers of Michigan was begun in 1885 by the fish commissioners of that State, the object of the same being to ascertain the results of previous efforts in stocking those waters and their suitability for different kinds of food-fishes. A small party, composed of regular employés of the State commission, has been assigned each summer to this field work, and an account of its researches down to 1888 will be found in the Seventh and Eighth Biennial Reports of the Michigan Fish Commission, published in 1887 and 1888. Not having had the services of a professional naturalist, the results have hitherto been incomplete from a biological standpoint, but by arrangement with the U. S. Fish Commission Mr. Charles H. Bollman, assistant in the University of Indiana, was designated as ichthyologist during the season of 1888. He was in the field from July 10 to August 19, when the investigations practically ended. The localities examined, arranged according to river basins, are as follows: *St. Joseph Basin:* Long, Austin, Indian, Gourd Neck, Rawson, and Howard lakes in Kalamazoo County. *Kalamazoo Basin:* The main river at Battle Creek and Marshall, Coguac, St. Mary's, Barnum, and Payne lakes, Upper and Lower Brace lakes, and Lyon Lake in Calhoun County. *Elk Basin:* Torch and Clam lakes, Rapid River and Spencer Creek in Antrim County.

In his report* Mr. Bollman briefly describes the physical characteristics of the several lakes, including their temperature at the surface and bottom, and notes the distribution of the species collected, which number 53. On account of its northern position, Michigan has, he states, comparatively few kinds of fishes, and as all the waters examined in 1888 had essentially the same physical features the list which he presents was, necessarily, a small one. The bottoms of the lakes were found to consist chiefly of fine mud or pulverent vegetable matter. Reference is made to the food of 23 species, which exhibited little diversity in that respect.

Iowa.—In the autumn of 1888, after the close of the Virginia explorations, Prof. S. E. Meek, whose residence is in Cedar Rapids, began the preparation of a report upon the fishes of Iowa, which will necessitate the examination of many localities where no collections have yet been made. This work will be continued from time to time, as his college duties will permit. In 1888 it was limited to Cedar River and its tributaries, chiefly in the neighborhood of Cedar Rapids.

Missouri and Arkansas.—The proposed establishment of a new hatching station at Neosho, in the Ozark region of Missouri, made it desirable to examine with some care the different streams in that vicinity. The services of Prof. C. H. Gilbert, of the University of Cincinnati, and of Prof. S. E. Meek, of Coe College, Iowa, were secured for that purpose, and the work was begun about the middle of July, 1888. The former, however, having been severely prostrated by malarial fever early in the season, the inquiry had to be deferred until the summer of 1889, when it will be taken up by Prof. Meek. The country about Neosho is chiefly drained by tributaries of the White River, but it is intended to extend the examination to the Osage River in Missouri, and the Arkansas and Washita rivers in Arkansas.

Alabama.—The investigations in Alabama were begun in the first part of May, 1889, and were continued a little over one month. The party consisted of Philip H. Kirsch, Everett O. Jones, and William M. Andrews, all students in the University of Indiana. Before reaching Alabama collections were made in Lake Pontchartrain, La., and in Biloxi Bay, Ocean Springs Bay, and Fort Bayou, Miss. In Alabama the explorations covered the greater part of the State, the number of places visited being indicated in the following summary: The Tennessee River and nine of its tributaries; the Alabama River and eleven of its tributaries; the Escambia River and eight of its tributaries. Prof. Charles H. Gilbert, who has reported upon the results of this expedition,†

*A report upon the fishes of Kalamazoo, Calhoun, and Antrim counties, Michigan, obtained in connection with the investigations of the Michigan Fish Commission during the summer of 1888. By Charles H. Bollman. Bull. U. S. Fish Commission, vol. VIII, for 1888, pp. 219–225.

†Report of explorations made in Alabama during May and June, 1889, with notes upon the fishes obtained in the bend of the Tennessee, the Alabama, and the Escambia rivers, and descriptions of three new species. By Charles H. Gilbert. Bull. U. S. Fish. Com., IX, for 1889, pp. 143–166.

states that with the exception of the larger river fishes, which were not obtained, the list of species presented is probably approximately complete for the bend of the Tennessee River, in the northern part of the State, but additional collections are still needed from the Alabama River. The examinations made in the bend of the Tennessee were chiefly noteworthy as showing the presence in the clear, cold, spring-fed tributaries of that portion of the river, of an unexpectedly large number of species characteristic of the headwaters of the French Broad and Holston rivers, which were studied by Dr. Jordan during the summer of 1888. Prof. Gilbert also includes in his paper the results of explorations made by himself and Prof. Joseph Swain, in 1884, and by Jordan, Evermann, and Bollman, in 1886. The number of species recorded from each river basin is as follows: The Tennessee River, 74 species; the Alabama River, 49 species; the Escambia River, 38 species.

Georgia.—In the latter part of June, 1889, Mr. Charles H. Bollman and Mr. Bert Fesler, both of the University of Indiana, began an investigation of the lowland region of Georgia. It was intended to continue the inquiry until about the middle of August and to extend it into the State of Florida. Mr. Bollman, however, was taken sick with dysentery fever at Waycross, Georgia, on July 4, and died on the 13th of the same month. The work was therefore abruptly terminated. Mr. Bollman was a recent graduate of the University of Indiana, where he was held in high esteem. Under the careful training of Dr. Jordan, he had acquired great proficiency as an ichthyologist and in other branches of zoölogy, having published several important papers on fishes and on the more obscure group of Myriapods. He gave promise of a bright and useful future and in a few years would, undoubtedly, have taken high rank among American naturalists. His loss is severely felt by the Fish Commission and by his many friends. During the short time this party was in the field, collections were made in Brier Creek, at Waynesboro; in a small creek in the southern suburbs of Savannah; in the Ogeechee River and one of its tributaries and in Buckhead Creek at Millen, and in the Satilla River at Waycross. Thirty-one species of fishes were obtained, including one new form, *Opsopœodus bollmani* Gilbert. The results accomplished have been described by Prof. C. H. Gilbert.*

Alaskan salmon rivers.—The great decrease in the production of the salmon fisheries of the Pacific coast between San Francisco and Puget Sound, during the past few years, has caused the salmon-packers of that region to turn their attention toward Alaska, where several species of the *Salmonidæ* occur in extraordinary abundance. Large and fully equipped salmon canneries have already been established at many

---

*Notes on fishes from the lowlands of Georgia, with a description of a new species (*Opsopœodus bollmani*). By Charles H. Gilbert. Bull. U. S. Fish Com., VIII, for 1888, pp. 225–229.

places in that territory, and an important and profitable industry has thereby gained a strong foothold in what is otherwise almost a primitive wilderness. In 1889 there were 36 of these canneries, 4 of which were located in Bristol Bay, 8 on Kadiak Island, 2 on Afognak Island, 5 on the east side of the Alaska Peninsula, 2 in Cook Inlet, and the remainder farther south along the coast. The total amount of capital invested was about $4,000,000, while the output for the year was valued at about $3,000,000. The resources of the Alaskan rivers in respect to this product have been considered by many persons, the fishermen and canners especially, to be practically inexhaustible, and such might be the case were the fishery conducted in a judicious manner and the habits of the salmon not materially interfered with. Many of the rivers, however, to which the salmon resort in great numbers, and which are conveniently located for the business, have short courses and comparatively shallow water near their outlets at times of low tide. In streams of this character the fish can readily be brought more directly under the control of man than in the longer and larger rivers in which the fishery has hitherto chiefly been carried on. The fishermen have been quick to recognize this advantage in devising means of capture, the most formidable and destructive of which have been traps and other forms of barricades reaching partly or entirely across the river. Meeting such a barricade the salmon congregate below it, and, still impelled by the breeding impulse to continue the ascent, remain entirely at the mercy of their captors, who can remove them with little trouble and at slight expense. To what extent this practice is now indulged in is not precisely known, and, we are, therefore, justified in supposing that only a small proportion of the fisheries are thus maintained, but a number of instances of gross misuse of the natural privileges have been reported, and as the canneries in any one locality increase in number the abuses are said to multiply.

The salmon interests of Alaska are actually of greater value than the sealing, and by proper management they can be made more permanent, but with unrestricted license they will as rapidly be destroyed. A knowledge of the habits of the salmon, joined with past experience in regard to the fisheries which they have provided, establishes the fact that this very important food product is also one of the easiest to exterminate, and should be well cared for.

During the winter of 1888–89 the attention of Congress was called to the salmon question in Alaska by residents of the Pacific Coast, who made an earnest appeal for immediate legislation to protect this source of industry before the rivers had become depleted. In compliance with their request the following act was passed and became a law on March 2, 1889:

AN ACT TO PROVIDE FOR THE PROTECTION OF THE SALMON FISHERIES OF ALASKA.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the erection of dams, barricades, or other obstructions in

any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than two hundred and fifty dollars for each day of the continuance of such obstruction.

SEC. 2. That the Commissioner of Fish and Fisheries is hereby empowered and directed to institute an investigation into the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions and methods of the fisheries, with a view of recommending to Congress such additional legislation as may be necessary to prevent the impairment or exhaustion of these valuable fisheries, and placing them under regular and permanent conditions of production.

In accordance with the provisions of section 2 of this act, the U. S. Fish Commissioner made arrangements to undertake the investigation therein directed during the summer of 1889. No specific appropriation having been made for that purpose, the expenses of the expedition were provided from the general appropriation. A party of four persons was organized to conduct the field work, the charge of the same being confided to Dr. Tarleton H. Bean, the ichthyologist of the Fish Commission, a well-known authority on Alaskan fishes and personally acquainted with the region to be studied. His associates were Mr. Livingston Stone, fish-culturist, Mr. Franklin Booth, topographical engineer, and Mr. Robert E. Lewis, rodman and general assistant. With the exception of Mr. Booth, these persons were all regular employés of the Commission. Dr. Bean left Washington in June, 1889, but the party was detained in San Francisco until July, through inability to obtain the necessary transportation, there being no regular line of steamers to that part of the Alaskan coast where they were to go. This exploration belongs, therefore, to the next fiscal year, but the plans and objects of the trip may be briefly stated here.

Kadiak and Afognak islands were selected as requiring first attention, as the greatest danger from overfishing had been reported from those places. In case the time permitted, the work was to have been extended subsequently to Cook Inlet, but the season proved too short to include that region in the scheme of operations. The observations of the party were to relate to the natural history of the salmon and their associated species, and the physical characteristics of their environment; the methods, statistics, and conditions of the salmon fishery; and the necessities and advantages of Alaskan waters for the artificial propagation of salmon. From the results obtained, it was expected to determine the extent and causes of any injury that had been done, and the proper remedies to apply, whether through legislation or through the aid of fish-culture.

PHYSICAL INQUIRIES.

Physical inquiries of one kind or another form a part of nearly all the field work that is carried on, and reference to them has been made under several other headings. Temperature and density observations are taken frequently by all the vessels in connection with their dredging and sounding operations at sea, principally at the surface and bottom, but to some extent also at intermediate depths. The arrangements made a number of years ago with the Light-House Board and Signal Service for continuous temperature records at certain of their stations still continue with satisfactory results, but the number of stations used for that purpose is much smaller now than formerly. Through the courtesy of the Southern Pacific Railroad Company similar observations are also taken at the railroad crossings of several of the large western rivers. The number of permanent stations in operation has proved totally inadequate, however, to accomplish what is most desired, namely, to determine the precise relations of temperature to the movements of migratory fishes, the isotherms corresponding with the advance schools. This subject has been partly worked up with respect to the shad, mackerel, and menhaden, but further data are required before definite conclusions can be reached. In case the laws which govern their movements can be fully demonstrated, it is rational to suppose that the arrival of any pelagic or anadromous fishes upon the sea-coast or along a river course may to some extent be anticipated and the fishermen be given warning of their near approach. The difficulties in the way of such a fortunate solution of this problem may be insurmountable, but as yet the matter has not been fairly tested, and it is only recently that the proper course to be pursued has been thoroughly comprehended.

The temperature stations of the Light-House Board, the Signal Service, and the Southern Pacific Company furnish continuous series of observations, which are taken twice daily at the light stations, and once a day at the others, the reports being submitted monthly. The light stations are chiefly in more or less exposed positions; those of the Signal Service in harbors, and those of the Southern Pacific Company at river crossings, as before explained. The names and locations of the stations which furnished information during the year are as follows:

TEMPERATURE STATIONS ON THE ATLANTIC COAST.

Stations of the Light-House Service:

Coast of Maine: Petit Manan Island, Mount Desert Rock, Natinicus Rock, Seguin Island, Boon Island.

Coast of Massachusetts: Race Point, Pollock Rip light-ship, Nantucket New South Shoal light-ship, Cross Rip light-ship, Vineyard Sound light-ship.

Coast of Rhode Island: Brenton Reef light-ship, Block Island southeast light.

Long Island Sound: Bartlett Reef light-ship, Stratford Shoals light-ship.

Coast of New York: Sandy Hook light-ship.

Coast of New Jersey: Absecon Inlet, Five Fathom Bank light-ship.

Stations of the Light-House Service—Continued.

Delaware Bay: Fourteen Foot Bank light-ship.

Coast of Virginia: Winter Quarter Shoal light-ship.

Chesapeake Bay: Point Lookout, Windmill Point, Stingray Point, Wolf Trap Bar, York Spit.

Coast of North Carolina: Bodys Island, Cape Lookout, Frying Pan Shoal light-ship.

Coast of South Carolina: Rattlesnake Shoal light-ship, Martin's Industry Shoal light-ship.

Coast of Florida: Fowey Rocks, Carysfort Reef, Dry Tortugas.

Stations of the Signal Service:

Eastport and Portland, Me.

Boston and Nantucket, Mass.

New York City, N. Y.

Charleston, S. C.

Key West, Cedar Keys, and Pensacola, Fla.

Stations of the Fish Commission:

Wood's Holl, Mass.

Fort Washington, Potomac River, Md.

Washington, District of Columbia.

TEMPERATURE STATIONS ON THE PACIFIC COAST AND SLOPE.

Stations of the Signal Service:

Portland, Oregon.

Stations of the Southern Pacific Company:

Colorado River at Yuma, Ariz.

Sacramento River, at Tehama and Yolo Bridges, Cal.

San Joaquin River, at the Upper and Lower Railroad Crossings, Cal.

King River, at Kingsbury, Cal.

Among the rivers the Potomac is best provided with observing stations, there being one at Fort Washington and another at the city of Washington, both operated by the Fish Commission, in addition to those above enumerated from Chesapeake Bay. It would add greatly to the value of the results if other important rivers could be as well supplied. Unfortunately, there are no stations at exposed positions on the Pacific coast, where arrangements have yet to be made for the study of temperature variations.

In Section III of the Fisheries and Fishery Industries of the United States, published in 1887, the writer presented a first report upon the results of observations made at the light stations on the Atlantic coast during the years 1881 to 1885, inclusive, the curves of temperature at each locality being plotted separately for each year on graphic charts. A more complete report, for which all the records down to date are being combined, is now in course of preparation.

The observations above discussed have reference chiefly to the shore waters and the rivers, although a few of the light-house stations are located somewhat off the shore, in exposed positions. The data derived from those sources can not, therefore, have much bearing upon the movements of pelagic fishes until they actually approach the coast. It is impracticable to establish permanent temperature stations in the open sea at a distance from the land, owing to the depth of water and

the expense of maintaining a sufficient number to afford appreciable results. Recourse must be had to other means for obtaining that information. The Fish Commission vessels are all provided with thermometers and density apparatus of the most approved patterns, but hitherto these have been regarded rather as accessories to the dredging and fishing outfit, and the temperature and specific-gravity observations have been supplemental to the collecting work. Consequently these observations have not been carried on systematically, either at fixed stations or along definite lines, and the records are of little value for determining the temperature and density variations in any special region. Until this subject has been studied in a thoroughly comprehensive way, we can not expect to make any advancement toward the explanation of those mysterious laws which govern the arrival and departure of pelagic fishes. Observations taken at the surface and bottom only are inadequate for the purpose. They must be carried through successive depths of water, being most numerous at those levels where the variations are most pronounced and the changes most frequent.

The investigations made by the steamer *Albatross*, between 1883 and 1887, have furnished the clearest insight into the physical characteristics of the waters off the Atlantic coast of the United States, especially south of New England and Long Island, where the greatest amount of work was done, and yet her observations are altogether incomplete for the purposes set forth above. The superficial relations of the Arctic current, flowing southward along the coast, and the Gulf Stream, flowing northward on the outer side, are generally understood. The serial temperatures taken by the *Albatross* show, however, that the transition from warm to cold water is not uniform at all depths and at all times, the Arctic current tending to indent the Gulf Stream on its inner face, producing in the same section very unequal bands of temperature, and indicating superimposed currents flowing in opposite directions. Another feature demonstrated by the *Albatross* was, that the border of the continental platform where the slope begins is partly bathed by the warmer waters pertaining to the Gulf Stream belt. Thus a somewhat tropical fauna is carried far northward, occupying a rather narrow zone between the cold water covering the inner surface of the platform and that which characterizes the deeper portions of the adjacent ocean. Here also was the habitat of the tilefish (*Lopholatilus chamæleonticeps*), whose sudden extermination in the spring of 1882 gave additional proof that the conditions which prevail in this region are unstable and fluctuating. The facts are insufficient to explain those conditions, but they indicate an interesting and perplexing problem in the solution of which important practical results may be anticipated. The principal pelagic fishes make their appearance from the direction of the Gulf Stream, moving inshore and northward as the season advances. With what hydro-isotherm is the approach of each species coincident, and do the movements of those isotherms correspond

with changes in the surface and atmospheric conditions which may be kept constantly under observation?

Plans were proposed sometime ago for running lines of observing stations across the mackerel region off the New England coast, with the object of obtaining several vertical sections to show the distribution of the bands of temperature, but owing to the press of other work they had to be indefinitely postponed. The subject was again brought up in the autumn of 1888 by Commissioner McDonald, who, after determining upon the character of results desired, referred the matter to Prof. William Libbey, jr., of Princeton College, to elaborate the details, the latter also having expressed his willingness to direct the investigations during the summer of 1889. The schooner *Grampus* was selected for making the experiments, and was thoroughly equipped for that purpose. It is intended that the work shall be carried on during the months of July and August.

During April and May, 1889, a series of density observations was carried through Chesapeake Bay from Baltimore southward, by Dr. C. F. Hodge, of Johns Hopkins University, with the view of obtaining data for comparison with the observations previously made on the oyster-grounds of Providence River and Long Island Sound. This work was incidental to a natural-history cruise conducted by students of the university.

Demands are frequently made upon the Commission for copies of the unpublished records of ocean temperature by persons interested in the study of climatology and of the health of seacoast towns, indicating that the value of those observations is not confined to fishery matters. All such requests have been complied with.

Acknowledgments are due to the Chief Signal Officer, U. S. Army, for the testing, gratuitously, of the delicate thermometers used in connection with the marine investigations.

THE WOOD'S HOLL STATION.

This station is one of the largest and most important of the Fish Commission, and is adapted to the needs both of scientific investigations and of fish-culture. Its location is excellent for both of those branches, being in the center of extensive marine fishing-grounds, whose threatened depletion first attracted the attention of Prof. Baird, and lying adjacent to the pathway of such well-known pelagic species as the mackerel, bluefish, and menhaden. The causes which led to the establishment of the station have been recorded in previous reports, as have also the incidents connected with its construction and equipment. During its first summer, that of 1871, the Fish Commission made its headquarters in this quiet little village, while its members found occupation in studying the surrounding fisheries whose unfavorable condition had occasioned much alarm. The results of that fishery investigation,

the first founded upon a scientific basis, were more than local in their effect, demonstrating, moreover, that precise methods of observation and deduction might be made as beneficial for this industry as for the kindred ones of agriculture and mining. The second year fish-culture was taken up as an adjunct in the replenishment of impoverished fishing-grounds in fresh water, but the work of exploration along the seacoast was continued and its scope enlarged. In the summer of 1872 the headquarters were at Eastport, Me., the center of the herring and of other important fisheries; in 1873 they were transferred to Portland, Me., and in succeeding years to Noank, Conn., Wood's Holl for a second time, Salem, Halifax, Gloucester, Provincetown, and Newport, ending with the latter place in 1880.

Down to the last-mentioned year, while the apparatus employed was the most perfect then available, the means for using it were more or less crude and were improvised for the occasion. The vessels were mostly small and not suitable for long trips, especially away from land, making it advisable to change the base of operations from time to time until the building of the steamer *Fish Hawk* in 1880. The importance of extending the inquiries to the offshore banks was made evident in that year by the researches in the tilefish region, and the project of building a larger sea-going steamer for that class of work brought with it the question of a permanent station where the vessels could find a rendezvous and the working party proper accommodations for their studies. Experiments in the propagation of cod had also been sufficiently advanced to indicate the utility of extensive operations in that respect. To join forces and build a station which should answer for all these purposes seemed most expedient, and this was the course pursued. Some of the reasons for selecting Wood's Holl as the site were the freedom of its waters from contamination and their high salinity (the strong tidal currents insuring a perfect circulation), and the somewhat temperate winters—the season when the cod work must be undertaken. At this point, moreover, several important species whose distribution is to the south of Cape Cod could be obtained, and a much greater scope could be given to hatching operations.

The essential features of the Wood's Holl Station are the large building serving as a hatchery and laboratory, the pump house or water tower, and the adjacent basins for the storage of living fishes. Besides these there is a dormitory for the assistants (the town itself affording insufficient accommodations for them), an ample coal shed, a storehouse, and well-constructed wharves for the mooring of the vessels. The first building was completed in 1884, the last in 1886.

During the lifetime of Prof. Baird, the steamers *Albatross* and *Fish Hawk* and the schooner *Grampus* made this place their headquarters during the warmer months, while engaged upon the survey of the northern fishing-grounds, returning after each cruise to deposit their load of specimens, to report their observations, and to replenish their

supplies. Many assistants skilled chiefly in the line of systematic zoölogy were required to care for the material brought in and to determine its character and bearing, but specialists in other branches were also present.

In the autumn of 1887 the *Albatross* started on its voyage to the Pacific coast, and subsequently the *Fish Hawk* was assigned to the investigation of the oyster-grounds. The withdrawal of these vessels from their customary summer grounds necessitated for a time the abandonment at the Wood's Holl Station of that class of inquiries for which their researches had so liberally provided. During the summer of 1888 the scientific laboratory was, therefore, chiefly utilized for the study of problems relating to the local fauna, the most practical being those which bore upon the embryology and life histories of useful fishes. The importance of such inquiries at the present time is especially great, in view of the efforts now being made to increase the fish supply along that portion of the coast. Of the daily habits of marine fishes very little is yet known, and the details of their embryology and later development have still to be explained with the majority of useful species. As our knowledge of the life history of each species becomes more perfect, its artificial culture becomes easier, and larger results are secured with less trouble and expense. Knowing the requirements of an egg for successful incubation, the appliances for hatching can be accommodated thereto and the mortality greatly lessened, while the young may be released in a more healthful and vigorous condition. Knowing the natural habits of the embryos, they may be planted more judiciously where the food and physical conditions are most suitable, and arrangements may be made in many cases for their feeding and rearing in confinement until they reach a size where their instincts and activity enable them much better to search for food and to escape their enemies. Similar studies are equally important for the lawmakers, affording them the information necessary as a basis for legislation regulating the fishing season and the methods of fishing to be permitted.

Researches of this character have always been encouraged at the Wood's Holl Station, but they have never been carried on there so extensively as during the summer of 1888. The small amount of money available for these inquiries permitted of the employment of only a few temporary assistants, and it was therefore, necessary to resort to the same measures which had prevailed in former years. The services of a number of volunteers were readily obtained in consideration of the facilities for work afforded by the laboratory, and properly qualified applicants for the remaining tables were allowed to be in attendance. While it is neither possible nor expedient in all cases to limit the investigations of such volunteers to subjects of immediate practical utility, their studies are nevertheless essential to the work and afford results which contribute in very great measure to its success. It is often impracticable to obtain the eggs of economic species at the time when the student is able

to conduct his observations, and, moreover, the eggs of some are so opaque or so minute as to make their study difficult. The eggs of kindred and non-commercial forms may then be utilized to good advantage, and their history may explain the facts desired. The teachings of morphology and histology, as well as of physiology, are equally essential to the interpretation of many questions which constantly tax the ingenuity of the breeders of aquatic animals, and it is only upon the broadest basis of biological deductions that their operations can be conducted intelligently and successfully.

In spite of these facts, the Government contributes nothing toward the compensation of those specialists whose time is not expected to yield a more or less direct gain. They are accorded such facilities as remain after the Fish Commission representatives have been provided for, and their good work is chiefly carried on under the stimulus which actuates the genuine seeker after truth. They are mostly professors and students in scientific institutions, who devote their vacation time, in such manner as they are best fitted, to the general advancement of knowledge. To the unselfish labors of men of this stamp and to their discoveries of great fundamental principles are largely due not only the development of fish-cultural methods, but of many important modern industries. The expediency of extending opportunities for research to this class of students is undeniable, and were it possible to offer still more substantial aid, the results would fully justify the means, as has been recognized in other branches of the Government service. By the payment of small salaries during about three months of each year a very able staff of workers could be organized, and under competent supervision their inquiries could be directed in the most appropriate channels.

The facilities of the Wood's Holl Station for observations and experiments respecting marine animals are unsurpassed elsewhere in this country, and probably also in Europe, except by the famous Naples laboratory. In the large laboratory building, the lower story has been specially fitted up for hatchery purposes, and contains the most approved appliances adapted to the propagation of marine fishes. These are at the service of the biological student who desires to trace the development of any set of eggs, permitting him to keep them constantly in view under the most favorable conditions afforded by a perfect system of water circulation. In the same room there is a larger series of aquaria and tanks, designed for the storage of embryo fishes while awaiting distribution, but available also for observations upon the growth and habits of any marine forms. The second story has been furnished chiefly in the interest of biological inquiry, being divided into several rooms, one of large size, the others suited to the requirements of one or two workers each. Salt water is distributed around the entire story by means of hard-rubber pipes having outlets at each window, where aquarial and study tables are provided. Larger aquaria

occupy the center of the main room, which is also supplied with other necessary conveniences for this branch of work. In the upper story there is a physical and chemical laboratory and a photographic studio. In front of the station are three basins of water, two of which are entirely inclosed, the third having an opening on one side for the passage of boats. The former are adapted to the penning of live fishes, and afford facilities for the study of their habits under conditions which are more or less natural. Several live-cars are anchored near the shore, and the station is well provided with small boats, including a sailboat and steam launch. The steamer *Fish Hawk* was at work in the neighborhood of Wood's Holl from August 5 to September 7, 1888, and the schooner *Grampus* made its headquarters at the same place during the latter part of the season, while investigating the mackerel region between Nantucket and Virginia. Opportunities for collecting were afforded by both of these vessels.

During the summer of 1888 the laboratory was in charge of Prof. John A. Ryder, of the University of Pennsylvania, formerly an assistant on the Commission, and widely known for his extensive and careful researches on the embryology of fishes and other aquatic animals. For the details of the work accomplished under his direction reference should be made to his report printed in Appendix 5 to this volume, pp. 513–522. The season lasted from July 1 until October, and during that period seven important educational institutions were represented at the station by the following investigators: The University of Pennsylvania by Prof. Ryder and Mr. W. S. Marshall; the Museum of Comparative Zoölogy of Harvard College by Mr. H. H. Field, Mr. W. McM. Woodworth, and Dr. and Mrs. C. H. Eigenmann; Johns Hopkins University by Prof. W. K. Brooks, Dr. E. A. Andrews, Mr. S. Watase, Mr. C. F. Hodge, and Mr. T. H. Morgan; Princeton College by Professor Miller, Mr. C. F. McClure, and Mr. J. Warne Phillips; Swarthmore College by Prof. Spencer F. Trotter; Wooster University, Ohio, by Prof. H. N. Mateer; and the Lake Laboratory at Milwaukee, Wis., by Dr. William Patten, who arrived at Wood's Holl early in June and remained until the latter part of July. Dr. Benjamin Sharp, of Philadelphia, was at the station in March, 1888, making a study of the development of the winter flounder or flatfish, *Pseudopleuronectes americanus*, which spawns at that time. Prof. S. F. Clarke, of Williams College, Prof. J. S. Kingsley, of the University of Indiana, and Mr. G. H. Parker, instructor in biology in the Museum of Comparative Zoölogy, were also present for a few days during the summer, chiefly for the purpose of obtaining material to be used in class demonstrations. The Commissioner established his office at the station during the latter part of the season, and Dr. T. H. Bean, the ichthyologist of the Commission, was there during the last few weeks, making some observations respecting the local fishes.

Professor Ryder's studies related to the embryology of the sea bass (*Serranus atrarius*) and the development and anatomy of the Atlantic

coast sturgeon (*Acipenser sturio*), but in addition he obtained a large collection of specimens representing the larval and post-larval stages of other fishes, on which his observations will be continued at Philadelphia. The work on the sturgeon was begun in Delaware Bay the previous spring, and was taken up with the object of preparing a comprehensive monograph on this important food species, whose rapid decrease in abundance is creating much apprehension among the fishermen. The results obtained, discussed elsewhere under the heading of the species, furnish the necessary information on which to base a successful system of artificial propagation. Regarding the material collected during the summer, Prof. Ryder states that it will help materially to fill in many existing gaps between the embryo and adult forms of fishes, thereby tending to throw much light upon the life history and habits of certain marine species respecting which more complete records are desired. Recognizing the importance of recording permanently the shape and coloration of the young as well as the adult stages of food-fishes, for the benefit of fish-culturists and of others interested in the subject from either a practical or a scientific standpoint, the services of Mr. S. F. Denton, an excellent artist and experienced naturalist, were secured for that purpose. His colored sketches made during the season represent twenty-three species, and were prepared from living specimens confined in the aquaria. This series, when completed, will, according to Prof. Ryder, "constitute a monograph of the most enduring, economic, and scientific value, as a contribution to fish-cultural literature."

The investigations of the scientific experts at the laboratory covered a wide range of subjects respecting the embryology, anatomy, histology, and physiology of fishes and marine invertebrates, such as the general and specific development of fishes, their osteology, the growth, structure, and functions of the different alimentary organs, the vascular system, the kidney, the brain, and other nerve tissues; the development, anatomy, and physiology of the king crab, the bait squid, annelids, ascidians, planarians, etc. Mr. C. F. Hodge, who had been engaged as naturalist to the steamer *Fish Hawk* for the oyster-starfish investigations in Providence River and Long Island Sound, began at Wood's Holl certain observations regarding the natural history of the starfish, with special reference to ascertaining what, if any, animals, preyed upon that species, and their relations to it. Dr. Brooks continued his elaborate studies on the life histories of the medusæ and hydromedusæ, begun some ten or twelve years before, and conducted previously on the southern Atlantic coast of the United States and at the Bahama Islands. The monograph which he now has in preparation will be one of the most complete and important ever published on these interesting groups, the wonderful transformations undergone by the different species being fully illustrated by the author's drawings. In the course of his summer's experiments Dr. Brooks found that delicate marine organisms will retain their form and structure and remain

flexible if killed in a solution of Perenyi's fluid and glycerine of the density of sea water and afterwards transferred to a mixture of alcohol and glycerine having the same density. As these qualities are exceedingly desirable in the case of all soft objects when preserved, Dr. Brooks's observations will prove of great utility.

Summarizing the results accomplished during the season, Prof. Ryder affirms that at least eight important monographic reports may be expected as the outcome, wholly or in part, of the investigations carried on at the Fish Commission laboratory.

The aquaria as a means of displaying living objects for the information of the public and for the study of their growth and habits, were made the subject of considerable experiment by the Commissioner, who has devised several improvements in respect to their aëration and illumination, and their adaptation for the drawing or photographing of marine specimens. As a direct result of his efforts, the aquarial display at Wood's Holl has been rendered more effective and its educational benefits have been increased. The importance of any improvements of a popular character at this place is very great, for, notwithstanding the comparative isolation of the village, the station is visited during each summer by a large number of persons, representing nearly every section of the country, and coming from the neighboring resorts or stopping over from the trains and boats which center there. The Commissioner also made a thorough study of the present and future needs of the station with respect to the supply and methods of distribution of both salt and fresh water, the former occasioning much trouble from its corrosive action on all kinds of metal piping.

Assistance was rendered to the investigators and students connected with the Marine Biological Laboratory recently established in Wood's Holl, by giving them the opportunity to make collections in company with the naturalists of the Fish Commission, on the expeditions with the steamer *Fish Hawk* and the steam launch. A similar courtesy was also extended to Prof. William B. Dwight and his pupils in natural history, of the summer school at Cottage City, Martha's Vineyard.

Although the Wood's Holl station has been regularly occupied for scientific puposes only during the summer months, or from June to October, there is one direction in which the work has been continued uninterruptedly and with great profit since the summer of 1871. In that year Mr. V. N. Edwards, a resident of the village and a self-trained collector and observer in natural history, was employed by Prof. Baird as a member of his party. After the close of the first season his services were retained for the collecting of fishes during the balance of the year, and his employment in that capacity has since been made permanent. Having become acquainted with the names of most species, his duties have been to record from day to day their presence and abundance as well as all other important facts regarding them, and to save and forward to Washington all the rarer forms taken and such exam-

ples of the commoner ones as seem desirable. So complete a record and collection have never been made elsewhere in this country or in Europe, and it is to be regretted that similar arrangements were not perfected at an early day with respect to other important places along the coast. The facts to be deduced from such a series of observations are the precise times when each species first approaches and leaves a particular region; the period of its increasing and maximum abundance; its spawning season; the character of the localities which it frequents for spawning and feeding purposes; its rate of growth and the habits and habitats of the young at different ages, and much other information respecting both the migratory and stationary fishes. The value of these data and their bearing on the broadest fishery questions in the directions both of fish-culture and of legislation, are too evident to require an explanation. Mr. Edwards's notes, which are very voluminous, are now being collated and prepared for publication. They will form a unique and valuable contribution to the literature of the fisheries. His material has been obtained by the use of different kinds of nets, by daily visits to the fixed appliances of the fishermen, and by keeping a constant watch upon the local markets. Moreover, since the completion of the new station a fish trap has been maintained alongside the stone pier during a part of each year, for the double purpose of obtaining food for the specimens kept in confinement and of adding to the natural-history record. During the summers, Mr. Edwards assists in the collection of specimens for the laboratory in addition to his regular duties, and he has also taken part in the experimental work of fish-hatching, as explained elsewhere. A complete collection of the fishes belonging to the Vineyard Sound region, including many rare and curious forms, has been brought together in the Wood's Holl laboratory by Mr. Edwards, as a type series for the use of specialists.

In order that the scientific observations respecting the embryology of food-fishes, many of which breed during the autumn, winter, and spring, may be continued during the entire year, Dr. H. V. Wilson, a graduate of Johns Hopkins University, has been appointed permanent naturalist at the Wood's Holl station, but his services were not secured until the middle of May, 1889. Dr. Wilson will also have immediate direction of the laboratory during the summer months, and opportunities for carrying on investigations will be offered to naturalists at all seasons.

No material changes have been made in the laboratory since it was first completed and equipped, beyond the addition of a few pieces of apparatus rendered necessary by the exigencies of the work. Only one of the small rooms has been plastered and made comfortable for occupation during cold weather, but in view of the proposed opening of the laboratory during the winter, it will be advisable to have other rooms finished in the same manner. The large laboratory, moreover, in order to adapt it to the greatest possible number of investigators, was fur-

nished with closely adjoining windows, leaving scarcely any wall space for shelving to accommodate the necessary books and reagents. It is proposed to partly remedy this defect by dividing a portion of the room into small compartments by low partitions, more for the convenience of storage than for isolating the different workers.

During the summer of 1888 a marine biological laboratory, designed to afford educational facilities as well as the means for special research, was established at Wood's Holl, within a block of the Fish Commission station. A two-story frame building suited to those purposes, measuring 63 feet by 28 feet, has been constructed and equipped, and was occupied during most of last season. The founding of an institution of this character so close at hand has been heartily welcomed as promising a friendly and sympathetic neighbor, whose opportunities for promoting the study of certain oceanic problems kindred to those which interest the Fish Commission will have a widespread appreciation. Not limited in its scope by questions of practical utility, its activity may include the widest range of subjects within the province of marine biology, and the vicinity of Wood's Holl furnishes abundant means to satisfy a majority of its needs. It is sincerely to be hoped that the beginning now made will eventually result in a large and permanent establishment, occupying a place in this country corresponding to the well-known Naples station of the Italian coast.

The requirements of the seaside student have hitherto been very poorly met in America, and there has been little encouragement for those engaged in this branch of education. Nearly all of the so-called summer schools have been chiefly occupied with instruction of a more or less elementary character, and none have been long-lived. The first of this class in the United States was established by Prof. Louis Agassiz on Penikese Island, but its duration was determined by its distinguished founder's death. Several others have followed on a smaller scale, one of the most prosperous and deserving being the seaside laboratory at Annisquam, maintained from 1880 to 1886 by the Woman's Education Association of Boston, in coöperation with the Boston Society of Natural History. The present marine laboratory is an outgrowth of the latter, and its organization is due to the efforts of several representative scientific men and women, of whom the larger proportion are residents of Boston and its vicinity. The necessary funds for the purchase of the land at Wood's Holl, and for the building and its equipment, were secured by contributions. A small fee is charged for instruction, and during last summer the investigators also were required to pay something for the privileges obtained, but in the future it is proposed to grant them all facilities without expense. The laboratory is still dependent upon the generosity of its friends, whose interest, however, is probably sufficient to insure its stability.

The director of the laboratory is Dr. C. O. Whitman, formerly of the Lake Laboratory, Milwaukee, Wis., but now professor of biology in Clark

University, Worcester, Mass. Seven persons were present last summer in the department of investigation and eight in the department of instruction. The facilities incidentally afforded at this place through the location there of the Fish Commission station probably had much to do with its selection as the site for the Marine Laboratory. On the other hand, the Commission has much to gain from its new neighbor, through the results of studies which its specialists are certain to make on the biology of fishes and through the opportunities to interest its workers in the practical objects of the fishery investigation, in regard to which substantial assistance may ultimately be derived.

SPECIAL INVESTIGATIONS.

The Sturgeon (*Acipenser sturio=oxyrhynchus*).

The condition of the sturgeon fisheries, both in Europe and in America, has occasioned much concern among the fishermen, owing to the steady decrease in the abundance of the common species, which form the object of this important industry. The Atlantic coast fishery in the United States, on its present distinct and extensive basis, is of comparatively recent origin, and has resulted in part from the increased favor with which sturgeon meat is now received, but even more from the growing demand for caviare both for local consumption and for the export trade. The statistics for 1888 place the catch of sturgeon on the Atlantic and Gulf coasts at 7,300,000 pounds, valued at $103,000, and the production of caviare at 486,000 pounds, valued at $68,000. New Jersey and Delaware lead all the other States in this industry.

In order to obtain more positive information respecting the advisability of attempting the propagation of the American species, and to determine what arrangements could be made for taking up that work, Mr. S. G. Worth was detailed in the spring of 1887 to make an examination of the extensive fisheries on the Delaware River and Bay. After diligent inquiry and personal observations extending through several weeks Mr. Worth was able to indicate the duration of the spawning period and to estimate the number of ripe fish obtainable during each season, besides collecting valuable statistics and visiting several places suggested as convenient sites for the location of a hatchery. Following out the same line of investigation, Prof. John A. Ryder, of the University of Pennsylvania, was induced the following spring to undertake for the Fish Commission a careful study of the embryology and life history of the sturgeon, on which to base a practical system of propagation. It was at first proposed that Prof. Ryder should operate in conjunction with the steamer *Fish Hawk*, then engaged in shad-hatching near the city of Philadelphia, but as the spawning fish could not conveniently be obtained in that locality, he proceeded to Delaware City, where his observations and experiments were conducted. While the field work relating to this subject was carried on during the fiscal year 1888, the material obtained was not fully elaborated until near the close of the present year.

Before discussing Prof. Ryder's investigations, it will be interesting to note the progress previously made in the actual hatching of sturgeon eggs. The principal activity in that direction has been displayed in Germany, where the work has been successfully prosecuted since 1877. The Germans, however, give credit for the first practical results to the New York State fish commission in connection with experiments on the Hudson River in 1875, and the Seth Green box then employed was used in Europe in its original form as late as 1885. On the German rivers the eggs are generally collected as they flow from the ovarian duct of the ripe females, their emission being sometimes aided by slight pressure. The last of the eggs are also occasionally obtained by making an incision into the abdominal cavity. The male organs are usually removed from the body and the milt is then extracted from them. After fertilization has been effected in pans, the eggs are transferred to floating-boxes. Difficulty has been experienced in obtaining a large quantity of well-advanced eggs, and especially in securing both the mature eggs and milt at the same time. The contents of the hatching-boxes were sometimes injured or scattered by storms and mold occasionally made its appearance on the eggs, but, considering the means available, the results have been exceedingly gratifying, although not as extensive as had been expected.

Prof. Ryder's observations,* beginning about the middle of May and extending through nearly all of June, 1888, were not confined to the embryology of the common form and the practical methods of handling its eggs, but extended also to its later growth, anatomy, and habits, to the present aspects of the fishery, and to the distinctive characters and relations of the two species which inhabit our eastern-coast waters. According to Prof. Ryder there are two sharply defined species on the Atlantic coast, the *Acipenser sturio* Linné, or common sturgeon, and the *Acipenser brevirostris* Le Sueur, the short-nosed or blunt-nosed sturgeon. The former is the only species of commercial value on the Delaware River and probably elsewhere along the coast. The latter is a much smaller form, and is also very rare, only five specimens having been obtained by Prof. Ryder during the entire season. Its characters had not hitherto been well defined, but Le Sueur, who first described it about 1817, while noting its scarcity, speaks of it as being much sought after as an article of food, commanding a higher price at Philadelphia than the larger species. At present, however, it is not marketed on the Delaware River, although it may be more common and attain a a larger size in other localities.

With respect to the embryology and development of the common species, Prof. Ryder explains that the ova when first extruded measure 2.6 millimeters in diameter. On the exterior of the eggs there is a

---

*The Sturgeon and Sturgeon Industries of the Eastern Coast of the United States, with an account of experiments bearing upon Sturgeon-Culture. By John A. Ryder. Bull. U. S. F. C., VIII, for 1888, pp. 231–281, pls. XXXVII–LIX.

considerable layer of glairy, viscid substance, "which becomes soft and stringy upon contact with the water, but hardens later into a firm substance, which finally cements the ova firmly to whatever they may be brought into contact with." The period of incubation lasted six days. The embryo when first hatched measures barely half an inch in length, and is provided with a large yolk sac. After a few days the latter is absorbed, and the young fish, then measuring nearly three-fourths of an inch long, must begin to forage for itself. Owing to its small mouth at this time, the food taken must be microscopic in character, and probably consists of rhizopods, unicellular algæ, infusoria, the minute larvæ of insects and worms, the very smallest crustaceans, etc. Specimens 1 to 1½ inches long were provided with minute teeth on the pharyngeal floor and had been feeding upon certain groups of the entomostraca, while amphipod and isopod crustaceans formed the principal food of those having a length of 5 inches to 2 feet. The adult fish, as may be inferred from the conformation of the head and mouth, are essentially scavengers and bottom feeders, and their diet probably includes a wide range of the more stationary forms of aquatic invertebrates. In the majority of the roe fishes brought to the butchering floats the spawn is nearly mature, being, however, still hard and firm and in the condition most highly prized by the packers of caviare. The variety best suited to the purposes of the fish-culturist is that which is just mature and ready to be artificially fertilized. According to Prof. Ryder,

Most of the eggs of the ripe roe have ruptured their follicles, and as soon as the abdomen is cut open the ova escape in great quantities, to the amount of several gallons in the case of a large fish. The quantity of eggs yielded by a single fish may, in fact, vary between 5 and 15 gallons. * * * It may be assumed that the average is about 10 gallons. * * * The eggs measure 2.6 millimeters in diameter, or a little less than one-ninth of an inch. At this rate we should find about about 168,000 eggs to the gallon, and a total of from 800,000 to 2,400,000, according to the amount of roe in a single fish, estimated in gallons.

The eggs, when in exactly the right condition, are globular, nearly a ninth of an inch through, and vary in color from a very light brown to a very dark brown. At one side a darker round disk may be observed, the diameter of which is about one-fourth of the circumference of the egg. This disk is also quite as visible in ova which have not yet escaped from the follicles in which they were developed as in the "hard roe," for example. The darker discoidal area is the germinal area of the egg of the sturgeon, and is the point where development first manifests itself to the unaided eye, through certain changes in its shape. The eggs of the kind above described should retain their globular form, like so many shot, and should show no sign of adhering to each other. If the round area at one side of the eggs should appear distorted or broken it is also a sign that the eggs are probably worthless for fertilization. Eggs with a round disk, if they flow freely from a slight cut through the walls of the abdomen of the recently caught living fish, may be fertilized without difficulty, provided a ripe male is at hand. Eggs which do not answer the requirements given in this paragraph it is not worth while to waste time over.

The reproductive organs of the males are not nearly as large as the ovaries of the females, and probably never much exceed 10 to 15 pounds in weight. If removed from the living male when mature, and cut open,

the milt may be extracted by pressure, and while Prof. Ryder was not successful with the milt obtained in this manner on two occasions, he thinks the eggs themselves may have been at fault and advises further experiments in this direction. In Germany this method has given good results.

The course to be pursued in the handling of the eggs is described by Prof. Ryder as follows:

Not more than twenty minutes should be allowed to elapse after the time the milt and eggs are mixed together till they are spread upon cheese-cloth trays, one egg deep, or in a single layer. If this is not done immediately the eggs will stick together in large masses, causing those at the center of these masses to be asphyxiated for want of oxygen, which under such circumstances can not find access to them. * * * It is, therefore, very important that a large number of trays properly constructed be at hand upon which to spread the eggs if any extensive hatching operations are to be conducted. The eggs will adhere very firmly to the surface of the cheese cloth in a few hours, after which further watchfulness is necessary in order to keep down any fungus which may appear upon the dead eggs, of which there will always be some. It may be possible that panes of glass would serve the same purpose as the cheese-cloth trays if a current of water were allowed to flow very slowly between a superimposed series of glass plates properly disposed in a trough. * * * Upon admixture with water the adhesive material with which the eggs are covered seems to be dissolved somewhat and becomes diffused through the water, so that the whole becomes ropy. * * * This glairy or ropy character of the partly dissolved coating of the egg persists for some time, usually for thirty minutes or so, after which time the glairy substance hardens or coagulates in the presence of the water and the gases held in solution by it. In process of hardening the glairy, sticky coating of the eggs firmly fastens them to whatever they are brought into contact with, and after that has occurred it is scarcely possible to detach them without injury to their delicate, thin envelopes and their soft, viscid contents.

* * * * * * *

The trays used at Delaware City, on board the steamer *Fish Hawk*, were made by tacking cheese cloth to light wooden frames a foot wide and 18 inches long, then loading the edges of the frames with strips of sheet lead to keep them immersed. These trays, placed on ledges in a superimposed series, in a trough through which the water is allowed to flow gently, is a very efficient hatching device. Floating hatching-boxes with brass-wire gauze bottoms and small openings at the sides covered with the same kind of gauze have been successfully used by the Germans, one having been brought from Germany by Mr. S. Feddersen, of Port Penn, Del., from Hamburg. The floating box in which the writer succeeded in hatching out a batch of the eggs of the sturgeon was exceedingly simple in construction, and consisted of a soap box with top and bottom removed, the bottom for which was then replaced by tacking cheese cloth to the lower edge of the rim, and by nailing wooden strips to serve as floats to the sides of the box a very efficient hatching device was extemporized. These boxes so modified were placed at the edge of the large fresh-water pool near the extreme eastern end of the Chesapeake and Delaware Canal, at a point where there was a constant flow of fresh water under them. The only lot of fertilized eggs which the writer succeeded in obtaining were spread on the bottoms of these boxes and left to hatch. In six days from the time of fertilization the young fish made their appearance. The rapid appearance of a parasitic fresh-water fungus, however, caused such extensive mortality amongst the eggs that very few embryos survived to escape from the egg membranes. This fungus, which appeared to be a *Saprolegnia*, is developed from spores which seem to be almost everywhere present in fresh water.

Prof. Ryder regards the development of this fungus as one of the most serious obstacles to sturgeon-culture, and, owing to the firm manner in which the eggs are fastened together, the separation at any time of the infested from the good eggs is practically impossible. As a prevention he suggests the filtering of the water supplied to the hatching boxes or its sterilization by means of heat.

The best source of supply for eggs was found to be the live fish which are brought to the Delaware City butchering floats, directly from the gill nets. If handled with a slight amount of care, they can be carried alive with the spawn in good condition. "Judging from the number of live spawning fish brought into Delaware City, Port Penn, and other places on the Delaware, there is but little doubt that several millions of ova for hatching purposes might be obtained each season by vigorous and faithful exploitation of all the sources of supply."

Prof. Ryder states his general conclusions with respect to the possibilities of sturgeon-culture and the methods to be followed in the following words:

The results which were obtained were to some extent unsatisfactory, owing to the difficulty of obtaining an abundance of living ova and the difficulties attending their fertilization by artificial means, as well as rearing the embryos. Notwithstanding this untoward condition, a number of novel facts were collected and experiments were carried out which must be of great significance in any further attempts at the artificial propagation of these immense fishes. Amongst the most important of my results, the observations which I regard as of the greatest practical value is the determination by experiment that it is possible to quickly obtain both living ova and spermatozoa from recently captured fishes by Cæsarean section. The only ova which I succeeded in fertilizing were obtained from females of the common sturgeon by cutting open the abdomen of the still living fish. Forcing out the ova by pressure, as practiced with the shad and salmon, is not feasible in the case of the sturgeon, and the removal of the ripe ova from the abdominal cavity of the parent fish may be far more expeditiously effected by slitting open the body cavity, in the manner usually practiced in dressing the carcass for market. * * * The success which followed the usual methods of fertilization proves conclusively that vast numbers of embryos could be hatched annually from eggs thus obtained and treated. The number of millions which could be reared in this way would depend entirely upon the number of trained spawn-takers promptly on duty when spawning fish are taken by the fishermen, and the extent of the facilities for hatching them and protecting them against the attacks of *Achlya* and *Saprolegnia*, forms of fungi which are found to be most seriously destructive to the life of the ova of the sturgeon in moderately quiet waters.

The Cod (*Gadus morrhua*).

The experiments in cod hatching have now been carried on at Wood's Holl a sufficient length of time to test their efficiency, but it is still too early to expect the presence there of large fish resulting from these efforts. Fortunately abundant evidence is at hand to prove the survival and healthy growth of a large percentage of the embryos produced at that place. In his annual report for 1883, Prof. Baird, referring to the first attempts at the artificial propagation of this species conducted at Gloucester, Mass., in the winter of 1878–79, explains that, "The fish

used for the purpose were the gray variety, believed to come from the offshore banks to the coast of the mainland for the purpose of spawning, the winter season being the period of this migration. During the following summer, small cod of the gray or offshore variety were met with around the wharves in the harbor, and at once attracted attention, such an occurrence being quite unheard of before. Again, the next year, these fish were found outside of the harbor, and of considerably larger size, fairly representing the second year of growth. The third year they were taken of a still larger size, and farther north along the coast, the fish of this school being universally known as the Fish Commission school."

The work was first started at Wood's Holl during the winter of 1879–80, when a few fry were planted in the neighboring waters. In 1885–86 it was again renewed, and has been continued down to date, the number of embryos liberated locally during the former and each succeeding year being, respectively, 3,000,000, 17,445,000, 8,840,000, and 9,175,000, a total of 38,460,000. The adult fish from which the eggs have been obtained belonged partly to the gray or offshore schools and partly to the red or rock variety. During his daily collecting trips in Vineyard Sound, Buzzard Bay, and the adjacent region, Mr. V. N. Edwards has secured much information which proves conclusively that this important experiment is already bearing fruit, and that as soon as the early broods have had sufficient time to grow an abundance of adult cod may be expected along this section of the coast. In considering the value of his observations it must be borne in mind that young cod, except occasional individuals, have not been known to frequent the waters about Wood's Holl within the memory of the oldest fishermen, and there is no reason to doubt that the evidence here presented bears solely upon the work recently conducted at the Fish Commission station. Mr. Edwards has kept himself informed, summer and winter, of the presence and movements of all the varieties of fishes in this region, both young and old, and the accuracy of his statements is unquestioned.

The fry produced in the winter of 1879–80 were planted in the little harbor of Wood's Holl, where the laboratory was then located. The following spring young cod were plentiful in both the little and great harbors, although only a few were seen elsewhere. In the fall of 1880 individuals from the same lot, measuring from 10 to 12 inches long, were found abundant at Menimsha Bight, inside of Gay Head, near the southern entrance to Vineyard Sound. The most pronounced results have been observed, however, since the winter of 1885–86, when the work was first established on a permanent basis, each succeeding year adding its large quota to the embryo colony. The fish hatched during each winter attain a length of 1 to 1½ inches by April 1; by the middle of June their size has increased to from 2½ to 3½ inches. Year-old fish measure from 12 to 13½ inches, and supposed two-year olds from 18 to 22 inches.

The young cod are first taken in the spring, about April 1, and con-

tinue present until about the 12th or 15th of June, when, the water becoming too warm for their comfort, they strike offshore. They are most abundant in May, being found near the shore on gravelly or stony bottoms, sometimes in small schools and occasionally associated with young pollock. During the springs of 1887, 1888, and 1889 they were plentiful about the wharves at Wood's Holl, remaining there until about the middle of May, when the cunners arrive. They leave the harbors earlier than they do the open shores of Vineyard Sound. May 8, 1888, Mr. Edwards estimates that there were at least 25 barrels of young cod, from 2 to 3 inches long, in one of the fish pounds which he examined in the neighborhood of Wood's Holl, and a bucket full was secured in a single scoop with an ordinary dip net. They had been equally abundant for a week previous, and their number did not apparently diminish during the succeeding ten days, when Mr. Edwards visited the same pound every morning. In other traps near at hand they were also very plentiful. This great display of young cod has, moreover, manifested itself during every spring since the winter of 1885–86, both in Vineyard Sound and in Buzzard Bay, the fish remaining near where they were planted until the rise in temperature drives them into deeper and cooler water.

During the spring of 1889 from 10 to 12 cod, measuring about 15 inches long, were taken nearly every morning in each of the fish pounds distributed through the sound between Vineyard Haven and Gay Head. It was the first season that fish of that size had ever been captured in the traps. It is the opinion of Mr. Edwards that the year-old cod will not approach the shore in the immediate vicinity of Wood's Holl, but will continue to frequent the more open waters of the sound and bay, and especially the region about Gay Head and Cuttyhunk, where the fishermen report them abundant during each spring and fall. Information received since July 1, 1889, indicates, however, that the fish of the earlier plantings are returning to the shallow waters in much greater numbers than seemed possible from the previous observations.

MISCELLANEOUS FISHES, ETC.

The excellent facilities afforded by the Wood's Holl Station for observations and experiments relative to the propagation of all kinds of marine fishes, in addition to the cod and lobster, have been put to use during the past few years, with most valuable and interesting results. The most important species for immediate consideration have been the scup and sea bass, both of which are the objects of an extensive local fishery, and were formerly much more abundant than they are at present. The mackerel also spawns in the vicinity of Wood's Holl, where its eggs may be obtained with little trouble. These and several other species breed in the spring and early summer, and the majority have floating eggs whose transformations are completed within a very brief period, the cod apparatus being well adapted to their hatching.

The work thus far accomplished in respect to these forms has chiefly been experimental, accompanied in part by observations on the development of the embryos, but it can, at any time, be placed upon a practical basis with the best assurances of success. Mr. V. N. Edwards has been especially active in regard to these matters, having collected most of the eggs and attended directly to their installation in the hatching apparatus. The following species have received attention during the past year:

The Scup (*Stenotomus chrysops*).

This species has floating eggs, of which 50,000, taken May 22, produced 30,000 fry May 27. In 1888, 50,000 ripe eggs, obtained June 4 and 5, were hatched with a loss of only 3,500.

The Sea Bass (*Serranus atrarius*).

The experiments with this species were also started in 1888 and continued in 1889. The eggs float, and hatch in five days. From 2,660,000 eggs taken in four lots between May 23 and June 10, 1889, 2,480,000 embryos were obtained, an unusually large percentage. The temperature of the water during this period was about 56° to 57° F. The ratio of success in 1888 had been nearly as great, but the number of eggs handled was considerably less.

The Mackerel (*Scomber scombrus*).

Capt. H. C. Chester and Prof. John A. Ryder began the experiments with this species in the spring of 1886, obtaining the spawn from three fish on May 19. As the eggs were of less density than sea water they were treated in the tidal cod jar, and began hatching at the end of ninety-four hours. The embryos were kept alive in the aquaria ten days, giving Prof. Ryder the opportunity to observe and figure their development up to that stage. In 1888 about 1,000,000 eggs were obtained between June 4 and 9, the same hatching between June 8 and 13 with a loss of less than 10 per cent. In 1889 only about 215,000 eggs were handled, having been collected May 21 and 24 and hatching May 25 and 28, with a loss of 30,000.

The Tautog (*Tautoga onitis*).

The egg of this very common species belongs to the same class as the preceding, as regards its specific gravity, and hatches in five days. From 100,000 eggs taken June 27, 1888, 88,000 fry were obtained, and 220,000 eggs taken May 21, 1889, produced 185,000 fry. The first experiments with this form began the latter part of May, 1886, and were carried on by Capt. Chester and Prof. Ryder, the latter paying particular attention to the development of the embryos, as in the case of the mackerel.

The Bonito (*Sarda sarda*).

This species also has floating eggs, of which the first lot, numbering 15,000, were obtained and placed in the apparatus June 7, 1889, hatching June 11, with a loss of only 2,500.

The Lobster (*Homarus americanus*).

Development and propagation.—In "The Fisheries and Fishery Industries of the United States," Sections I and V, the condition of the lobster fishery was discussed upon the basis of the information obtained as late as 1882. It was there shown that a considerable decrease had taken place in the abundance of the American species, the supply in some places having so greatly diminished as to practically destroy the local industry. Since that period the evidence at hand indicates that this decrease is still continuing, in spite of the somewhat rigid laws which have been passed by the New England States and New York. The same trouble has been experienced in Europe, and in both countries the problem of how to protect the grounds and restore their prosperity has been fruitful of discussion and experiment. Among crustaceans the eggs, as they are emitted, become attached to external appendages of the body, where they remain until the hatching takes place. In the artificial propagation of the lobster it has, therefore, generally been considered necessary to confine the parent with its eggs until the appearance of its progeny. The difficulties in the way of such an undertaking may readily be conjectured. The imprisonment, care, and feeding of a sufficient number to afford appreciable results would involve an expense wholly out of proportion to any good that might be accomplished. Several private parks for experimental work in that direction have been established from time to time, but they were soon abandoned.

Early in the summer of 1885, the Norwegian fish-culturist, G. M. Dannevig, announced the successful hatching of lobster eggs that had previously been removed from the parent. The new laboratory at Wood's Holl, with its perfect system of running water, had just been completed, and it was determined to undertake at once similar experiments with respect to the American species, notwithstanding the hatching season had already terminated. The trials were begun by the writer and were continued by him and by Capt. H. C. Chester until about December. The results have been fully discussed in the Bulletin of the U. S. Fish Commission for 1886, pp. 17–32. Only a very small number of embryos, about 50, were produced during this period, indicating that it is not expedient to conduct the work outside of the natural breeding season, but much valuable experience was acquired respecting the manner of obtaining and caring for the eggs. Lobsters with eggs attached to the swimmerets are found during the entire year, but the hatching season is confined to about two months, beginning, in the Vineyard Sound region, early in May and continuing into July. At whatever season the eggs may be extruded they develop slowly until that period, and, with our present knowledge of the subject it is not advisable to collect them at other times. As they pass from the body of the female they are coated with a viscid substance that soon hardens into short, tough, and flexible threads, by means of which they are attached in clusters of variable sizes to the swimmerets or leaf-like

appendages on the lower side of the abdomen or "tail." The eggs are hardy, comparatively large, about one-twelfth of an inch in diameter, and each lobster carries at a time from 6,000 to 36,000, dependent partly upon its size. The circulation of water among them is maintained by the natural movements of the swimmerets, which indicate, in a measure, the amount of motion to be given them in the hatching apparatus. As the attaching threads do not constitute an organic connection between the eggs and the body of the lobster, they may be cut without causing injury to the former or suffering to the latter, and the eggs may be removed rapidly by means of scissors or a sharp knife. They are heavy and the McDonald automatic hatching jar is well adapted to their incubation, although the cod apparatus has also been successfully used for the same purpose.

In the spring of 1886 the experiments were renewed by Capt. H. C. Chester and Prof. John A. Ryder, and were carried to a successful issue, being vigorously prosecuted during the entire hatching season. Prof. Ryder also made a careful preliminary study of the development of the young,* and attempted the rearing of the embryos in confinement. When first hatched the embryo lobster is totally unlike the parent, both in shape and in the character of its appendages, leading also a pelagic or free-swimming existence. Each stage of growth is marked by the casting off of the outer skin or shell and the formation of a new one. The early transformations are quite rapidly accomplished. The history of the embryo at this time was carefully recorded by Prof. Ryder, who found that six molts occurred during the period of their free existence, which occupied from six to seven weeks in the aquaria. The molts take place at intervals of four to fifteen or more days, if the larvæ are well fed. During the first, second, third, and fourth stages, occupying about three weeks, the embryos have the essential characteristics of a low group of shrimps, called schizopods, their appendages being chiefly adapted to swimming. With each molt the embryo becomes slightly larger and new appendages are added. From a length of 8 millimeters at hatching, they attain a length of 13 millimeters in the fourth stage. With the fourth molt, which gives rise to the fifth stage, having a length of 14 millimeters, the embryo loses its schizopodal characters, being abruptly transformed into a type very closely resembling the adults. Formerly transparent, its color now is a bluish green, with more or less brown in some cases. During the fifth week, or toward the close of this stage, the young lobster becomes less partial to its earlier pelagic life, and remains on the bottom a great part of the time. In the sixth stage it has attained a length of 19 millimeters, and in the seventh a length of 22 millimeters, the latter being reached at an age of about seven weeks. During these three last stages the body and its appendages have been rapidly assuming the form and pro-

*The Metamorphosis of the American lobster, *Homarus americanus* H. Milne-Edwards. By John A. Ryder. American Naturalist, xx, No 8, pp. 739–742, August, 1886.

portions of the adult, which are still more marked in the eighth stage, the final one that was observed, and during the same period its disposition to remain upon the bottom has also increased.

Not being supplied with a yolk sac, the embryo lobsters begin to feed immediately after hatching. They are carnivorous and cannibalistic, devouring their own kindred by preference and with evident relish. They are ravenous eaters, very savage and persistent in their attacks upon one another, interposing thereby a serious obstacle to any attempts at their confinement in the aquaria. Otherwise it would be advisable to hold them until they had passed through their early larval stages and were ready to begin their permanent life upon the bottom. At that age they are better able to escape their enemies and to search for food, but under existing conditions it has been necessary to plant them when only a few days old. Prof. Ryder found that the greatest mortality occurred during the first four stages. The fifth and following stages are more hardy, and would give comparatively little trouble in practical operations. Their harder shell, their approach to the adult habits, and the greater ease with which they can be fed all conduce to this. These later stages were fed upon crab roe, copepods, and other minute crustacean life, and sometimes with chopped meat, but it was found essential that the food should be given in a fresh condition and should not be allowed to become stale or to putrefy in the tanks. The experiments with regard to feeding and rearing in the aquaria will be continued during subsequent seasons in the hope of reaching more satisfactory conclusions in that respect.

It is still too early to measure the success of lobster-culture, and until the same can positively be determined it has not been considered prudent to conduct the work upon a large scale or to extend it beyond the Wood's Holl region. In the summer of 1888, 325,000 embryos were planted there, and in 1889, 1,575,000 embryos. The growth of the lobster is supposed to be comparatively slow, the age of individuals measuring 10 inches long having been estimated all the way from 6 to 10 years, although we have no definite information on which to base such calculations. Any increase in the supply would not, therefore, have manifested itself up to the present time, and several years must still elapse before passing finally upon the utility of the experiments. The urgency of the case is such, however, as to warrant most strenuous efforts to attain success. The destruction of lobster eggs in nature through the attacks of eels, cunners, and other small fishes, is known to be very great, while most of the egg lobsters taken by the fishermen find their way to market, despite the laws. Artificial propagation is at least beneficial in insuring the utilization of the latter and the preservation and hatching of a larger percentage of the former, precisely what is accomplished in all branches of fish-culture. It is evident, however, that more stringent and judicious legislation will be required to fully protect the lobster-grounds, even to the entire suspension of

the fishery for a time in certain districts, but that is a matter which falls entirely within the jurisdiction of the States.

Transplanting.—The two commoner species of lobster (*Homarus*) are limited in their distribution to the North Atlantic Ocean, one occurring on the European the other on the American side. The American species ranges as far south as Delaware, but is most abundant on the coasts of New England and the British Provinces. Its north and south distribution is undoubtedly determined chiefly by temperature, and it would, therefore, seem impracticable to attempt its extension artificially in those directions. On the Pacific coast, however, similar conditions are again repeated, although warmer waters are there carried farther north by currents, as on the coast of Europe, producing a somewhat milder and more equable climate in corresponding latitudes. That such a coincidence does exist on both sides of the continent is substantiated by the fact that both the cod and halibut inhabit the North Pacific, ranging south beyond Cape Flattery, and that other fishes and many marine invertebrates seem to be identical in the two oceans. From some cause, however, the lobster has been excluded from the fauna of the Pacific coast, and its place has not been taken by any other species, but it does not seem possible that its absence is due to climate. The only locality in that region for which we have a continuous series of temperature observations of the sea water is San Francisco, where during the six years ending with 1886 the range of temperature was only 10° F., or from 51° to 61° F. At the mouth of Vineyard Sound, off Wood's Holl, Mass., the range of ocean temperature during seven years was 37° F., or from 32° to 69° F. The temperature is, therefore, much more equable at San Francisco than on the southern coast of Massachusetts, corresponding for the entire year, with the conditions prevailing at the latter place between May 20 and the last of June and between the first of October and the middle of November. Both of these periods are favorable to the existence of lobsters on the inshore grounds, and the former is also the spawning season. So far as temperature is concerned, the Pacific coast appears to offer no obstacles to the introduction of lobsters even as far south as San Francisco, and probably Monterey, the next adjoining bay. The coast from here northward presents a succession of sandy and rocky shores, sufficiently rich in life to afford an abundance of nutritious food, and, if once successfully started, there is every reason to expect that they would thrive and multiply.

The question of the introduction of lobsters in this region is not, however, to be decided solely by the fact that the conditions are favorable to them. It is equally important to know if they are wanted by the inhabitants and if they would add a desirable feature to the food supply. This question was practically settled as early as 1873, when California took the initiative in attempting the first transplanting of lobsters across the continent, having, however, in that matter, the coöperation

of the U. S. Fish Commission. The fact that a large crustacean called the spiny lobster or salt-water crayfish (*Panulirus*) occurs to the south of Point Conception is not an argument against the introduction of the genuine lobster. A closely related "crayfish" inhabits the south Atlantic and Gulf coasts, and another species the southern part of Europe, both of these being highly esteemed as food, but not interfering to any extent with the fishery for the true lobster (*Homarus*). On the first shipment the train was totally wrecked soon after crossing the Mississippi River. A second trial was made in 1874, and a third in 1879, only four lobsters reaching San Francisco alive on the former and twenty-one on the latter. Realizing that the planting of such small lots could have no appreciable effect in the stocking of a new region, experiments were made at Wood's Holl in the spring of 1886, by the late Capt. H. C. Chester, with the view of determining some more economical and reliable method of transportation. His efforts were directed chiefly toward the preservation of lobsters by packing them in moist sea weed and reducing the temperature of their surroundings. They were entirely satisfactory, specimens being kept in good condition for several weeks, with the use of only a very small amount of sea water, and, while not strictly imitated in the subsequent shipments, they suggested the methods that were pursued.

As this division of the Fish Commission was called upon to assist in the preparation of these shipments, a brief reference to them may be made in this connection. They have, however, been fully described in the Bulletin for 1888, pp. 453–472. The lobsters were collected in the Vineyard Sound region, and after being loosely packed in rock weed in small wooden crates, were stored in the large compartments of one of the Fish Commission cars, in which the temperature was reduced by means of ice and salt. At least twice each day the specimens were freshened by sprinkling them with salt water, of which a stock was carried for that purpose. The first trip was made between June 16 and 23, 1888, beginning with 610 lobsters, of which 250 were males and 360 females. The second trip took place between January 14 and 22, 1889, starting with 710 lobsters, 279 being males and 431 females. Some of the females in both lots were also provided with eggs. A comparison of the difficulties encountered on these two trips is interesting. The first was made during a period of very warm weather, and the mortality from that cause was very great, despite the free use of ice. The second was, therefore, arranged to obviate that trouble, but unfortunately the temperature during the journey fell at times considerably below zero, and it became necessary to resort to artificial heat to prevent the absolute freezing of the lobsters, but nevertheless the mortality was even greater than before. As a result of the first trip, 302 lobsters were planted in Monterey Bay and vicinity, and 30 off Trinidad light-house in northern California, besides about 100,000 embryos deposited off Monterey. On the second trip 88 individuals were planted off Cape

Disappointment, 22 in Shoalwater Bay, and 123 in different places at the mouth of Puget Sound, all within the limits of the State of Washington. A number of years must elapse before the utility of these plantings can be ascertained, and it is probable that several more shipments will be necessary to place these little colonies on a self-sustaining basis, but the undertaking is sufficiently important to warrant every reasonable effort in its behalf.

The Long Clam (*Mya arenaria*).

A discovery made in regard to the young clam at Wood's Holl, by Prof. Ryder, while at first sight apparently of biological interest only, can be turned to good account in case the transplanting or artificial culture of that species is attempted. In fact, its distribution to different parts of the Pacific coast, where it is not a native, but where it has already obtained an accidental foothold, has been seriously considered, and an unsuccessful trial in that respect was made by the steamer *Albatross* in 1888. Hitherto, in the transplanting of mollusks, the adults generally have been used, and the oyster, most fortunately, is able to withstand the hardships of a long journey. The clams, however, are more delicate and their transportation for stocking purposes has generally ended very disastrously. Respecting his observations, Prof. Ryder wrote in December, 1888, that he had discovered a byssus and byssal sac in the tip of the foot of the common clam, in young specimens collected at Wood's Holl during the previous summer, which fact upsets all previous ideas regarding the life history of that species. Instead of the young clam burying itself at once in the sand like its parent, it probably suspends itself for a time to weeds or sticks or other objects above the bottom until it is large enough to shift for itself in its final home. The presence of a byssus in the young of this animal seems to be a protective measure, and it will be interesting to learn if the giant clam, *Glycimeris generosa*, of the Pacific coast, is similarly provided in its embryo state. The specimens from Wood's Holl were found on floating timbers among ascidians, and ranged in size from less than a millimeter to nearly three-fourths of an inch long. Its transplanting while so attached could readily be effected.

THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF AMERICAN FOOD-FISHES, MOLLUSKS, AND CRUSTACEANS.

The first and only extensive investigation of this important subject that has been made in this country was begun for the Fish Commission about ten years ago by Prof. W. O. Atwater, of Wesleyan University, Middletown, Conn., who has continued his observations from time to time as funds could be spared for that purpose. Having, moreover, a deep personal interest in the successful accomplishment of his task, Prof. Atwater has given largely of his time and means without remuneration, and some financial assistance has also been received from Mr. E. G. Blackford, of New York, and Mr. A. R. Crittenden, of Middletown, Conn.

Considering the large number of species of aquatic animals, estimated at about a thousand in this country, which are used for food or for other economic purposes, and the amount of time required to make a careful analysis of a single species, some idea may be formed of the magnitude of any inquiry that would include the entire list. Whether or not it will eventually be considered advisable to analyze all or even the larger proportion of these edible forms is a matter not requiring immediate decision, but in his experiments thus far Prof. Atwater has selected a wide variety of species, including the more important ones, sufficient to furnish most instructive and interesting results. Preliminary reports upon the investigation were published in the Fish Commission Reports for 1880 and 1883, and contributions on the same subject by Prof. Atwater have also appeared in the Report of the Shellfish Commission of New York for 1887, the National Medical Dictionary, and the Century Magazine during 1887 and 1888.

In view of the progress that has been made and the opportunity afforded for deductions, it has been deemed expedient to present in this volume a full account of the researches now completed, and Prof. Atwater's paper (Appendix 10, pp. 679–868) is deserving of careful consideration. The author explains that in its present status the investigation includes: (1) Chemical analyses of the flesh of American food-fishes and invertebrates; (2) experiments upon the digestibility of the flesh of fish; and (3) studies of the chemical constitution of the albuminoids of the flesh of fish. The experiments in regard to the last-named subject are not, however, sufficiently advanced to warrant their discussion at the present time. The report is divided into two parts, the first treating of chemical compositions, the second of nutritive values. Part I is chiefly occupied with the technical details of analyses, while Part II is more popular in character and explains the deductions at which the author has arrived, together with their bearing upon different fishery problems.

The total number of species of fishes analyzed was 55; of mollusks, crustaceans, etc., 11; but the number of specimens, and consequently of separate analyses, was very much greater. The invertebrates made use of consisted principally of oysters from different localities, together with scallops, clams, mussels, lobsters, crayfishes, crabs, and shrimps. Many other kinds of food materials have also been subjected by Prof. Atwater to the same tests for the benefit of the National Museum, and the results obtained thereby are here utilized for comparison.

The comprehensive manner in which the subject has been presented may be inferred from the following references to the principal contents of the report. In Part I are given the classification and origin of the specimens examined; methods of analysis; descriptions and details of the analyses; the results of the analyses presented in tabular statements; protein in the flesh of fishes; classification of the specimens in accordance with their chemical composition; summary of the analyses

of European fishes made by different observers, and the comparison of the same with those of American fishes; and changes in the composition of oysters by removal from salt to brackish or fresh waters. Part II treats of the constituents of foods, their principal nutrients, and the way in which those nutrients are utilized by the human body in the formation of tissues and for sustaining the vital functions; the digestibility of fishery products; the relative value of the different species of fishes, mollusks, and crustaceans, according to the percentages of their component nutrients, the same being illustrated by tabular statements and colored diagrams; the objects and results of the floating of oysters, and oysters considered as an article of food.

Without extending these remarks beyond their proper limits it would be impossible to give an adequate idea of even the more important features of Prof. Atwater's investigations, but his final conclusions may very appropriately be quoted, as they are at least suggestive to all promoters of fishery matters. They are as follows:

The chief uses of fish as food are (1) as an economical source of nutriment and (2) to supply the demand for variety in diet, which increases with the advance of civilization and culture. As a nutriment, the place of fish is that of a supplement to vegetable foods, the most of which, as wheat, rye, maize, rice, potatoes, etc., are deficient in protein, the chief nutriment of fish. The so-called nitrogenous extractives (meat extract) contained in small quantities in fish, as in other animal foods, are doubtless useful in nutrition.

* * * * * * *

Late inquiry in agricultural and biological chemistry has brought out some facts which emphasize the importance of fish-culture and the greater use of fish as food from the standpoints of hygiene and domestic, agricultural, and even national economy. Our national dietary is one-sided. Our food contains relatively too much of fat, sugar, and starch, and too little of protein. This is a natural result of our agricultural conditions, which have led to the production of large quantities of maize (which is relatively deficient in protein) and of excessively fat beef and pork. Our agricultural production is in this sense one-sided. Our soils are becoming depleted by culture. The evil results of this are already evident in the older and are becoming so even in some of the newer States of the Union. Of the ingredients of plant food which are needed for the restoration of fertility, the costliest and scarcest is nitrogen, which is the characteristic element of the protein compounds of our food.

A very large amount of the waste products which are left from the consumption of food, instead of being returned to the soil for restoring its fertility and increasing its production, is carried off in drainage waters and through the sewers of the large cities into the rivers and sea. The nitrogenous products are thus especially exposed to loss. The nitrogen, however, is not lost necessarily in this way. It goes for the support of marine vegetation which forms the food of fish. It may thus again be utilized as food for man. Fish has relatively less of fats and more of protein than meats and vegetable foods. By fish-culture, then, we are enabled to supply the very materials which are lacking in our dietaries and from the waste products may be saved the valuable fertilizing elements, including phosphorus and especially nitrogen.

As population becomes denser, the capacity of the soil to supply food for man gradually nears its limit. Fish gather materials that would otherwise be inaccessible and lost, and store them in the very forms that are most deficient in the produce of the soil. Thus, by proper culture and use of fish, the rivers and sea are made to fulfill their office with the land in supplying nutriment for man.

THE WASHINGTON LABORATORY, PREPARATION OF REPORTS, ETC.

During the lifetime of Prof. Baird all the accommodations required for conducting the scientific work of the Fish Commission in Washington were provided by the U. S. National Museum. The same arrangements were also continued until June, 1889, when, upon the refitting of Central Station, the scientific quarters were removed to that building. Formerly the collections of natural-history specimens as soon as they were received in Washington were transferred to the custody of the National Museum, which also provided for their maintenance and, to a great extent, for their elaboration. In the future the Fish Commission will retain possession of such materials until they have been studied, then depositing them in the National Museum, with which it is expected that the friendly coöperation so long maintained will be continued. Dr. Tarleton H. Bean has also been retained by the Museum as curator of the Department of Fishes and Mr. Richard Rathbun as curator of the Department of Marine Invertebrates.

The scientific work to be provided for in Washington, besides the routine of administration and the direction of investigations, is the preparation of reports, maps, and plans, and the study of natural-history collections, and of physical and chemical problems. The accommodations assigned to this division at Central Station comprise an office and laboratory with several storerooms. The laboratory is especially fitted up for biological inquiries, but may also be used for physical and chemical researches upon a limited scale. The facilities for the storage of collections are sufficient for immediate purposes, but they will undoubtedly soon be outgrown. Not having the means for keeping up the very complete physical laboratory established in the Smithsonian Institution under the direction of Dr. J. H. Kidder, the privileges so graciously afforded there were relinquished toward the close of the fiscal year, the apparatus belonging to the Fish Commission being transferred to Central Station. Arrangements were at once made with the Chief Signal Officer and with the Superintendent of the Coast Survey for the testing of all the more delicate instruments, the coarser ones being readily attended to in our own laboratory. The physical observations are made chiefly in the field, and the subsequent preparation of reports upon those subjects seldom requires the use of apparatus. It would, however, be advisable to enlarge the facilities for that branch of investigation in Washington, and it is hoped that this may soon be accomplished.

The scientific collections received in Washington during the past year have been very large and valuable, representing inquiries extending over a wide extent of territory. The most important were those obtained by the steamer *Albatross* on the voyage from Washington to San Francisco in 1887–88, and during the subsequent surveys on the

coasts of Alaska, Washington, and Oregon; by the steamer *Fish Hawk* while on the west coast of Florida and in Providence River and Long Island Sound; by the schooner *Grampus*, on the red-snapper banks of the Gulf of Mexico, and by the inland parties investigating the lakes and rivers. The principal material transferred to the National Museum consisted of the type series of fishes from the inland explorations, the reports of which had been completed, and of the mammals, birds, reptiles, plants, geological and ethnological specimens obtained incidentally during the recent cruises of the *Albatross*. Duplicate sets of the fishes collected by the inland parties were also distributed to several institutions, as described elsewhere, and many groups of animals were sent to specialists for study and report. The distribution of duplicate natural-history specimens, however, is chiefly made through the U. S. National Museum, which is better equipped for that purpose.

The large and fine collection of fishes and marine invertebrates obtained by the steamer *Albatross* during the voyage from Washington to San Francisco in 1887–88, described in the last annual report, was received at Washington in July, 1888. The assorting of the material was undertaken by Prof. Leslie A. Lee, of Bowdoin College, who had been in charge of the scientific work of the expedition, and early in the winter the different groups had been carefully separated and prepared for study. For the working up of these collections, which contain many unique and interesting forms, and the preparation of reports upon them, it was necessary to obtain the coöperation of many specialists who could afford to give their time gratuitously. Much assistance of that character was fortunately secured, and by the close of the year the following assignments had been made: The deep-sea fishes and those collected along the shores of southern South America, to Dr. Tarleton H. Bean; the shore fishes of Santa Lucia, West Indies, Bahia, Brazil, the Galapagos Islands, and Panama, to Dr. David S. Jordan; the fishes from between Acapulco, Mexico, and San Francisco, to Prof. Charles H. Gilbert; the brachyuran, isopod, and phyllopod crustaceans, to Prof. Leslie A. Lee; the stomatopod crustaceans to Prof. W. K. Brooks; the alpheid crustaceans, to Prof. F. H. Herrick; the pycnogonids, to Prof. E. B. Wilson; the annelids, to James E. Benedict; the nematod and trematod worms, to Prof. Edwin Linton; the salpæ, to Prof. W. K. Brooks; the gastropod, scaphopod, and lamellibranch mollusks and the brachiopods, to William H. Dall; the pteropod and heteropod mollusks, to James I. Peck; the crinoids and echini, to Prof. Alexander Agassiz; the corals, to Richard Rathbun; the actinians, to Prof. J. P. McMurrich; the medusæ, to Prof. W. K. Brooks; the hydroids, to J. Walter Fewkes; the foraminifera, to Prof. L. A. Lee; the algæ, to Prof. W. G. Farlow.

Many fishing implements collected on the voyage were added to the fishery exhibition in the National Museum, and all animals and other objects not aquatic were transferred at once to the custody of that

Museum, where they have been placed in the hands of the following persons for study: The mammals, to F. W. True; birds, to Robert Ridgeway and L. Stejneger; bird's eggs, to Capt. Bendire; reptiles and batrachians, to Prof. E. D. Cope; skeletons, to F. A. Lucas; insects, to L. O. Howard; plants, to Dr. George Vasey; archæological specimens, to Thomas Wilson.

The voyage of the *Albatross*, on which this material was obtained, offered exceptional advantages for scientific observations, which were fully utilized, and the reports upon the different subjects will form one of the most important series of contributions yet resulting from any of the Government expeditions. The opportunity afforded was incidental to the transfer of the steamer *Albatross* to the Pacific coast, and was planned by Prof. Baird shortly before his death. The reports will be published mainly in the Proceedings of the National Museum.

Attention is directed to the exceptional advantages for the study of salt and fresh water animals now afforded by the large series of aquaria recently established at the Central Station in Washington under the immediate direction of the Commissioner. These facilities will be appreciated especially by the student of marine zoölogy, and as a means of popular education in respect to the habits of living fishes they will also serve an important purpose.

At the Cincinnati Centennial Exposition, held during the summer of 1888, the opportunity was taken to illustrate the methods of work pertaining to this division and some of the results of its investigations. The steamers *Albatross* and *Fish Hawk* and the schooner *Grampus* were represented by means of models and photographs, and the appliances for marine research chiefly by the instruments themselves. The following material was also exhibited: A relief model of the great offshore fishing banks of Eastern North America; series of dried and alcoholic specimens to show the fauna of the marine fishing-grounds, the character of the ocean bottom, the food of pelagic fishes, and the principal economic fishes and marine invertebrates; living specimens of the food-fishes of the Ohio Valley kept in aquaria; series of microscopic preparations illustrating the development of several of the food-fishes now being propagated by the Fish Commission, and the biology of many other fishes and invertebrates; and the publications relating to the scientific inquiries of the Fish Commission.

REPORT UPON THE DIVISION OF FISHERIES.

By J. W. COLLINS,
Assistant in charge.

A.—INTRODUCTION.

The second report on the division of fisheries, which is herewith presented, covers the fiscal year ending June 30, 1889, and shows concisely the work of the division during the year.

In reviewing the operations of the division, its organization, and the investigations in which it has been engaged, it is well to have in mind the fact that the work was carried on under peculiarly adverse conditions, due to the fact that the exigencies of other branches of the Fish Commission work made it necessary for me to devote almost all of my time to duties not directly connected with the division. Elsewhere more detailed mention is made of this; here it will suffice to say that, in addition to my connection with the exhibit of the Commission at Cincinnati, I was assigned to the following duties: (1) That of fitting the *Grampus* for sea in the summer of 1888, and employing a captain to take command of her. (2) That of attending to some special matters at Gloucester, Mass., relating to the fish-cultural work at that station. (3) That of making an official investigation of the circumstances connected with the stranding, abandonment, and rescue of the *Grampus*; also making repairs, fitting her for sea, and employing officers and men to go on her. (4) Preparation of reports as follows: (*a*) On the investigation above referred to; (*b*) on the construction and equipment of the *Grampus*; (*c*) on the operations of the *Grampus* from March 15, 1887, to June 30, 1888; (*d*) on the participation of the Fish Commission in the exposition of the Ohio Valley and Central States, together with a catalogue of the exhibit.

B.—RESOURCES AND EXPENDITURES.

Appropriation.—The available means for conducting the inquiries prosecuted by the division of fisheries during the year 1888–89, for the preparation of reports, and for the payment of salaries, etc., consisted of an appropriation of $10,000, in addition to which $5,000 was assigned by the Commissioner from the appropriation for scientific inquiry for a "study of the methods and relations of the fisheries."

Need for economy.—The extended scope of the work of the division, the great expanse of territory to be canvassed in the obtainment of statistical and descriptive data, and the relatively small sum available for the investigations have made the most careful use of the funds necessary. It is thought that expenses of the field agents for travel and subsistence (including railroad and steamboat fares, carriage and boat hire, hotel bills, etc.) have been kept remarkably low, and that the average daily expenditure of $3.86 per man will compare favorably with the record for other branches of the Government service.

Analysis of disbursements.—The funds of the division were expended as follows:

Salaries	$10,940.08
Travel and subsistence of agents	2,980.21
Miscellaneous, including printing, supplies, furniture, etc	853.95
Total	14,774.24
Balance	225.76
Amount of appropriation	15,000.00

C.—CONSIDERATION OF THE STATUS OF THE WORK, ITS PROGRESS, ETC.

PERSONNEL AND DUTIES.

Changes in personnel.—During the year there have been many changes in the personnel of the division of fisheries, due to various causes, among which the chief have been the general expansion of the work and the assignment of certain persons from the division to the preparation and conduct of the exhibit made by the Fish Commission at the Centennial Exposition of the Ohio Valley and Central States. The following notes in relation to the personnel will present a clear idea of the changes indicated:

Assignment of persons to other duties.—As was mentioned in my report for the previous year, it became necessary, in carrying on the work of preparing and conducting the exhibit of the Commission, to detail to duty in connection therewith Messrs. E. C. Bryan and W. H. Abbott, who continued in service at Cincinnati until the close of the exposition. Mr. H. R. Center, who was temporarily assigned to duty in connection with the preparation of the exhibit, resumed his ordinary duties in the division soon after the beginning of the year. He was detached from the division of fisheries on November 30, 1888, and assigned to duty in the division of scientific inquiry.

Special assignments and duties in office and field.—The following noteworthy assignments to special duties were made during the fiscal year:

During my absence from Washington (to which more extended reference will be made elsewhere), Mr. Hugh M. Smith was placed in charge of the office work, acting under my direction, with the exception of the time during which he was employed in fieldwork, when the office affairs

were under the immediate charge of Mr. W. de C. Ravenel. Early in the year Mr. Smith was ordered to investigate the fisheries of Virginia, Maryland, Delaware, Pennsylvania, and New Jersey, assisted by Mr. M. M. Snell. The work was begun on July 12, 1888, and he returned to Washington October 6. During the remainder of the year Mr. Smith was chiefly engaged, together with Mr. Snell, in the compilation of the report on the fisheries of the Great Lakes, which was completed in the spring of 1889 and submitted for publication. He also had charge, under my direction, of the preparation of statistics and of the general work of the statistical office.

Mr. W. de C. Ravenel was assigned by the Commissioner to duty in the division of fisheries immediately after the close of the season for hatching shad at the so-called Battery Station, Maryland, of which Mr. Ravenel was superintendent. During the absence of Mr. Smith in the field Mr. Ravenel had charge of the office work, as before stated, and rendered efficient service. In the early winter he was ordered to make an investigation of the fisheries of the South Atlantic coast from Florida to North Carolina. Entering upon the work on December 3, 1888, and beginning his investigation in southern Florida, he carried the inquiry as far north as the vicinity of Elizabeth City, N. C. On March 27, 1889, he was ordered to Washington and assigned to other duty in connection with the division of fish-culture; but as soon as the work at the Battery Station was completed, in the spring, he was again detailed to assist in the work of the division of fisheries.

Mr. M. M. Snell was ordered to assist Mr. H. M. Smith in the investigation of the fisheries of Maryland, Virginia, Delaware, Pennsylvania, and New Jersey. He began work on July 12, 1888, and completed his investigation on December 31 of the same year. After his return he was engaged mainly in assisting in the compilation of the report upon the fisheries of the Great Lakes.

Mr. W. A. Wilcox began a canvass of the fisheries of eastern Massachusetts, including Gloucester, on July 2, 1888. The investigation was discontinued August 15, 1888. On November 15, 1888, he was detailed to make a canvass of the fisheries of the Pacific States, including the river basins, and at the close of the year was engaged in this work and had made good progress, being then in the Puget Sound region.

Mr. Luther Maddocks was ordered to make an investigation of the fisheries of Maine on July 1, 1888, and began work in the vicinity of Boothbay. The investigation was suspended on August 15, 1888, and Mr. Maddocks was relieved from duty.

On April 4, 1889, Mr. W. H. Abbott was ordered to Elizabeth City, N. C., to complete the investigation of that State which had been inaugurated by Mr. Ravenel. The work was finished and Mr. Abbott returned to Washington on June 13, 1889.

On January 3, 1889, Capt. D. E. Collins was placed on the rolls of the division of fisheries and ordered to make an investigation of the

fisheries of the Gulf States, including western Florida. He began at Key West and prosecuted the inquiry along the west coast of Florida, and thence westwardly. On April 22, 1889, the canvass was abandoned at Scranton, Miss., the failing health of Capt. Collins rendering it impossible to continue the inquiry.

On May 8, 1889, Mr. Ansley Hall was appointed as a statistical agent and ordered to collect statistics and study the methods and relations of the fisheries in Rhode Island. At the close of the year this investigation was still in progress.

Mr. Charles H. Stevenson was appointed a statistical agent on May 2, 1889, and on May 6 was detailed to make an investigation of the fisheries of New York. The inquiry had not been completed at the close of the fiscal year.

Capt. S. J. Martin was employed as resident agent at Gloucester, Mass., in collecting statistics of the daily receipts of fish from vessels and boats.

On April 15, 1889, Mr. F. F. Dimick was appointed as the resident local agent at Boston, Mass., for the collection of fishery statistics at that port.

Mr. E. F. Locke, who is the custodian of the fish-hatchery at Gloucester, has been detailed to assist in the collection of statistics at that port, and at the close of the year is engaged in that duty.

After the completion of his duties in connection with the exposition at Cincinnati, Mr. E. C. Bryan was detailed to assist in the compilation of the report prepared by me on the construction and equipment of the *Grampus*, and also the report concerning her operations. Later he was assigned to his regular duties in the division of fisheries.

Mr. C. B. Hudson was employed as artist for the division from September 15, 1888, to the close of the fiscal year. In the early part of the year he was employed as artist in connection with the preparation of material for the Fish Commission exhibit at Cincinnati.

Mr. J. J. Corridon was detailed from the Commissioner's office to assist me in an official investigation of the stranding and abandonment of the *Grampus*, etc., and later he was assigned to the office of statistics of the division of fisheries and placed on its rolls.

Mr. T. W. Keller was assigned to duty in the division of fisheries July 1, 1888, and continued in the service of the division until March 31, 1889, when he was transferred to the fish-cultural division. His work in the office was chiefly in pasting newspaper clippings.

Mrs. I. M. Palmer was detailed from the Commissioner's office for duty in the division of fisheries to assist in the work of pasting and classifying newspaper clippings.

Mr. H. E. Martin was appointed as clerk in the statistical office of the division on July 11, 1888, and resigned on March 31, 1889.

Mr. S. Le R. Pritchard was appointed as clerk in the statistical office of the division on April 16, 1889.

Miss Lillian M. Collins was appointed as clerk on April 8, 1889, and assigned to the duty of classifying, arranging, and indexing newspaper clippings.

List of employés and their salaries at the close of the year.—The following is a list of the employés of the division and their salaries at the close of the year. This does not, however, include the names of those who have been temporarily detailed to service in the division from other divisions of the Commission:

Name.	Designation.	Monthly compensation.
J. W. Collins	Assistant in charge of division	$200
W. A. Wilcox	Statistical agent	115
Hugh M. Smith	Clerk	100
E. C. Bryan	do	100
J. J. Corridon	do	100
C. B. Hudson	Artist	75
M. M. Snell	Clerk	75
W. H. Abbott	do	65
S. Le R. Pritchard	do	50
Lillian M. Collins	do	50
S. J. Martin	Local statistical agent	50
Ansley Hall	Statistical agent	45
C. H. Stevenson	do	30
F. F. Dimick	Local statistical agent	25

FIELD WORK, SOURCES OF INFORMATION, ETC.

General considerations.—The work, as considered under this heading, is that which relates more particularly to the obtainment of information upon which reports can be based, and is distinct from the routine work and the preparation of reports, which will be mentioned later.

The principal sources of information are: (1) Special investigations prosecuted by the statistical or field agents; (2) the statistical circular of the Treasury; (3) reports received from local statistical agents and fish bureaus; (4) general correspondence; (5) newspaper clippings.

Special investigations.—The special investigations undertaken by the division during the year were as follows:

An inquiry into the statistics, methods, and relations of the fisheries of the Middle and South Atlantic States, from New York to Florida, inclusive, all of which was completed before the close of the year with the exception of New York.

A similar inquiry concerning the fisheries of the States bordering on the Gulf of Mexico was undertaken but was not finished. A canvass was made, however, of the coast from Key West to Scranton, Miss.

A comprehensive investigation of the fisheries of the west coast was begun in November, 1888, and at the close of the fiscal year was so well advanced as to give reason to anticipate its completion at a comparatively early date. This included a canvass of the coast and river fisheries from San Diego to Puget Sound. It is expected that this will be supplemented, so far as the commercial fisheries are concerned, by the work done by Dr. Bean and assistants in Alaska in connection with

the investigation of the salmon rivers of that region, of which fuller mention will be made in a subsequent report.

In the early part of the year inquiries were begun in New England, more especially in Massachusetts and Maine, but, owing to my absence from Washington and the difficulty of properly directing the work under the circumstances in which I was then placed, the Commissioner thought it necessary to suspend the work, which he did on August 15, 1888. Toward the close of the year, however, the investigation was resumed, and, in addition to the work performed by the local agents at Boston and Gloucester, a special agent was sent to Rhode Island to make a canvass of its fisheries. It is proposed to continue this work so as to cover the entire coast fisheries of New England, and it is expected that the inquiry will be completed in a few months.

Treasury circular, statistics of the fisheries.—Through the continued courtesy of the Treasury Department, the Fish Commission receives, from the various collectors of customs, reports on this circular covering the operations of fishing vessels. The value and condition of these returns were fully discussed in my previous report. The number of statements received during each fiscal year since the circular went into effect is as follows:

1886	892
1887	5,088
1888	5,436
1889	4,846
Total	16,262

Reports of S. J. Martin.—Capt. Martin, resident statistical agent of the Fish Commission at Gloucester, Mass., has continued to send monthly and semimonthly reports to this division. These show the daily arrivals of vessels, the amount of fish landed by each, the localities where the fish were taken, and many other valuable data, including the statistics of fish landed by boats operating from Gloucester harbor, catch of the local fish-traps, etc.

Reports of F. F. Dimick.—Since his appointment, on April 15, 1889, Mr. Dimick has furnished the division with monthly reports showing the arrivals of fishing vessels at Boston, the quantities of fish received, importations of fish products, etc., together with the grounds upon which the fish were taken. He has also submitted statistics of the vessel and boat fisheries of Boston and vicinity, including persons employed, capital invested, and amount and value of catch.

The Boston fish bureau.—The daily trade reports of the Boston fish bureau, which have been sent to the Commission free of charge, have furnished information concerning the arrivals of fishing vessels at Boston and other ports, and a general statement of the amount of mackerel and other salt-fish products landed by them, together with much other data relating to the fresh and salt fish trades, condition of foreign markets, etc.

Correspondence.—Many of the correspondents of the Commission, and especially those in direct communication with the office of the division of fisheries, have shown a disposition to furnish information whenever called upon. In many cases parties have voluntarily sent important data bearing upon the fisheries that have been utilized in descriptive papers and statistical presentation.

Newspaper clippings.—In my last report allusion was made to newspaper clippings as being valuable for reference when properly classified. The efforts which have been made to render available this class of material have, on the whole, been satisfactory, and good progress has been made in the latter part of the year.

ROUTINE WORK.

That part of the work of the division which may properly be classified as routine, and of which there is a large amount in connection with the compilation of statistics, may be placed under the following heads:

Work relating to statistical circulars.—This consists (1) in acknowledging to collectors of customs the receipt of circulars containing statistics of the fisheries; (2) registering the same; (3) examining circulars and making comparisons for the detection of errors; (4) correcting errors (which sometimes involves considerable correspondence), and (5) making compilations.

Miscellaneous correspondence.—There has been a large amount of miscellaneous correspondence relating to the general work of the division. This has been chiefly with members and committees of Congress, with the statistical agents in the field, with parties engaged in the fisheries, etc.

Card catalogue.—The system of keeping a card catalogue of fishing vessels sailing from the United States has been continued and elaborated, and has proved a valuable adjunct in carrying on the work. This catalogue contains a complete record of the life history of each vessel since 1885, so far as the information has been obtained in the office, and by its means it is feasible to trace the work and movements of the fishing craft of the United States.

Classification of newspaper items.—The classification of newspaper clippings containing items relating to the fisheries may properly be classed as routine work. Allusion was made to this in my previous report, where it was stated that a rough classification had been attempted. Until the latter part of the year it was not feasible to do more than this, though two clerks were detailed to the work of pasting and arranging the clippings. Later, however, a satisfactory attempt was made at a systematic classification, and the success achieved at the close of the year gives good promise to expect gratifying results from the work.

Pressure of routine work.—Owing to the unusual efforts which have been put forth during the year in the prosecution of special investiga-

tions and in the preparation of extensive reports on the fisheries, the pressure of routine work has been such that the small force available has been required to make an extra effort to carry it on. My own absence from the office, in connection with other affairs, together with the detail of some of the most efficient clerks to other duties, naturally brought an additional pressure of work upon those who remained in Washington.

PRACTICAL WORK OF THE DIVISION.

General considerations.—In view of the many matters which have served to handicap the operations of the division during the year, the progress of the work in connection with the preparation of reports has been most satisfactory. As stated in my last report, when the division of fisheries was organized, near the close of the last fiscal year, the work on the compilation of reports in the office was either not commenced or in a very embryonic condition. Notwithstanding this, and despite the pressure of extensive field investigations, much has been accomplished, as will appear from the statements which follow:

REPORTS AND SPECIAL PAPERS SUBMITTED FOR PRINTING.

1. The Beam-Trawl Fishery of Great Britain, with notes on Beam-Trawling in Other Countries. (23 plates; 34 text figures.)
2. Review of the Fisheries of the Great Lakes in 1885. (39 full-page plates of fish, apparatus, etc., and 6 folding charts, showing number and location of pound-nets.)
3. The American Sardine Industry.
4. Notes on Certain Fishery Industries of Eastport, Me.
5. Some Reasons why the Fishermen of Nova Scotia prefer to use Salt Clams (*Mya arenaria*) for Bait in the Bank hand-line Cod Fisheries.
6. Statistics respecting certain features of the vessel fisheries of the United States.
7. Suggestions for the employment of improved types of vessels in the market fisheries.

REPORTS AND PAPERS IN COURSE OF PREPARATION.

1. Report on the construction and equipment of the schooner *Grampus*.
2. Report upon the operations of the U. S. Fish Commission schooner *Grampus*, from March 15, 1887, to June 30, 1888.
3. Notes on the crab fishery of Crisfield, Md.
4. Statistical and descriptive notes on the the fisheries of the Middle Atlantic States.
5. Notes on the fisheries of the Lower Chesapeake Bay.
6. Report and catalogue of the Fish Commission exhibit at the Centennial Exposition of the Ohio Valley and Central States.

STATISTICAL STATEMENTS, DESCRIPTIVE PAPERS, ETC., FURNISHED TO CONGRESS, THE EXECUTIVE DEPARTMENTS, STATE OFFICIALS, AND OTHERS.

A large amount of material that comes under this head is annually supplied by the division. Some of it requires great research and is of such a nature that it is suitable for publication in the reports of the

Fish Commission, but as a rule such information is too specialized or local in its application to warrant printing by this Commission although frequently used for that purpose by the parties and bureaus to which sent.

It is not necessary to mention here all the statements regarding the various phases of the commercial fisheries for which request has been made and which have been furnished by this office. The following list is submitted more as an index of the work and capacity of the division than as a résumé of its entire annual operations.

1. Statement of the Alaska salmon pack from 1883 to 1888, inclusive.
2. Table showing by customs districts and fishing-grounds the number of vessels engaged in the offshore bank fisheries of New England in 1888.
3. Statement showing the oyster product of the United States.
4. Statistical tables exhibiting the mackerel catch, by United States vessels, in the Gulf of St. Lawrence, during the years 1883, 1884, and 1885.
5. Tabular presentations showing the extent of the fishery industry of Sandusky, Ohio, and of Lake Erie; also of British Columbia.
6. Statement of the extent of the fishing fleet on the Grand Banks of Newfoundland and the number of vessels belonging to each country.
7. Statistical summary of the fisheries of North Carolina.

NOTICE OF SPECIAL MATTERS AFFECTING THE FISHERIES.

As in my previous report, it is intended, under this head, to call attention to certain matters that may not in all cases be directly connected with the work of the Fish Commission, but which, nevertheless, have such an important bearing upon the relations or prosperity of the commercial fisheries of the country as to warrant mention of them.

As a rule, every year is noteworthy for a series of events that affect, in one way or another, the present or future of certain fisheries, and perhaps few years have been more noticeable in this direction than the one covered by this report.

Fishery treaty with Great Britain.—Among the noteworthy events of recent occurrence none seem of greater moment than the treaty affecting the fishery relations between the United States and Canada, which was negotiated with Great Britain during the last fiscal year, reference to which was made in my previous report.

It is pertinent to mention in this connection the fact that the State Department was furnished by the Commission with a large number of copies of Sections I to V, inclusive, of the "Report upon the Fisheries and Fishery Industries of the United States," a special edition being printed for this purpose.

In addition, the Commission supplied the American commissioners with numerous statistical statements, with special papers on fisheries, and with colored maps showing the distribution of the most important species of fish, mollusks, etc., taken for food or bait between Cape Hatteras and the coast of Labrador at the intersection of the 53d degree of latitude. Besides this. the experts of the Commission rendered val-

uable service in making personal explanations of matters affecting the fisheries in North Atlantic waters.

This treaty, when submitted to the Senate, was not ratified. It is, however, noteworthy that the *modus vivendi* attached to it is to continue for two years, and this provision will probably have more or less influence upon such fisheries as are liable to be affected by it.

Scarcity of mackerel.—The common mackerel (*Scomber scombrus*), which constitutes one of the most important objects of fishery in the North Atlantic, was exceptionally scarce during the season of 1888,* and, so far as could be judged from the amount taken, its lack of abundance was even more marked than during the previous year, though that also was considered an unusually bad season for mackerel fishermen.

The cruise on the southern mackerel grounds made by the *Grampus* in the spring of 1888—during the closing months of the last fiscal year—developed the fact of an alarming scarcity of mackerel, and in a measure prepared the fishing interests for the conditions met with later in the season. Nevertheless, though the fleet was not so large as on previous years, many vessels engaged in the fishery, the failure of which has entailed much financial loss upon those sections most largely interested in this industry. The result has been particularly unfavorable in its influence upon small fishing communities which have depended largely on the mackerel fishery. In some cases the effect upon these has been disastrous and discouraging, and places heretofore prosperous have received a check that it may take many years to recover from, if, indeed, their interests in the fisheries are not in a large measure permanently destroyed.

As in all cases of business disaster, particularly where the conditions are not definitely understood, many causes are assigned for the scarcity of mackerel, and many methods are suggested to secure their abundance. It is, perhaps, needless to say that those most prolific in assigning causes and suggesting remedial measures are often least qualified from study and experience to speak on the subject. It is not practicable to refer in detail to these matters here. It may suffice to say that the cause for the scarcity of mackerel most commonly assigned is the use of the purse-seine in their capture, while some have advised not only the abandonment of fishing with this form of apparatus, but the entire discontinuance of net-fishing of any kind. In view of the fact that the mackerel has been celebrated for its erratic habits; that there have been periods of scarcity and abundance ever since the settlement of the country; that the destruction of the species was apprehended in colonial times, long before the invention of the purse-seine, and re-

* It is practicable here to speak only of the seasons or calendar years, since the opening of the mackerel season, for vessel fishing, is limited by law to June 1 of each year, and it rarely happens that many fares are landed before June 30. For this reason the catch of the season of 1888—June 1 to November—is essentially the product of the fiscal year, at least so far as the landing of the vessels' catch is concerned.

strictive laws were then passed regulating the fishery, when the total catch did not exceed that which one vessel might make now in a reasonably prosperous season—it is easy to see that the present depletion of the species is simply a repetition of history, and any measures which are intended to remedy it should be carefully considered.

It is probable that nothing can be done which will entirely change the conditions resulting from the habits of the mackerel, though it is possible that the conditions may be materially affected and a reasonable abundance of the species be maintained continuously by artificial propagation. If millions of fry can be produced, and particularly if these can be protected and reared artificially through their earlier stages, when the greatest depletion is liable to occur under natural conditions, there is at least reason to hope that similar results will be secured as in the case of the shad.

Artificial freezing of fish at Gloucester, Mass.—An event fraught with great possibilities to the fisheries of New England is the adoption of the system of freezing fish at Gloucester, Mass., by artificial methods, such as have been in common use in the Great Lakes region for a number of years.

As long ago as 1878, when making his summer headquarters at Gloucester, Prof. Baird suggested the advisability of the adoption of freezers by the fishing interests of that city. However, this wise and timely advice was not heeded, and there seemed no disposition among the dealers to profit by it until ten years later, when Mr. William H. Jordan consulted with the writer as to the advisability of establishing a freezing plant on his premises at Gloucester.

It is gratifying to record that a freezer on the most approved plan has been put into operation during the present fiscal year, and Mr. Jordan has also applied this principle of artificial freezing to some of his vessels which were sent for cargoes of frozen herring to Newfoundland. The most gratifying results have been secured on the vessels thus supplied, since they succeeded in securing cargoes of frozen herring far in advance of those dependent on natural freezing, and since in consequence they reached home and a market at an earlier date, and were enabled to secure higher prices and much greater profit than otherwise could have been obtained. It seems safe to predict that, in view of the uncertainty of climate at Newfoundland, this method of freezing herring on board the vessels by artificial means will become a fixed factor in the trade, and will ultimately extend to considerable proportions.

PARTICIPATION IN THE CENTENNIAL EXPOSITION OF THE OHIO VALLEY AND CENTRAL STATES.

In my report for the last year, and in the preceding chapters of this report, allusion has been made to my connection with the exhibit of the Fish Commission at the Centennial Exposition of the Ohio Valley and

Central States, which was held at Cincinnati during the summer and autumn of 1888. Mention has also been made of the fact that some of the experienced clerks of the division of fisheries were detailed to duty in connection with the exposition. In a special report on this subject (which appears contemporaneously with this) detailed mention is made of all these matters. It may suffice to say here that my duties in connection with the exposition kept me at Cincinnati until November, 1888, and were not entirely discontinued, after my return to Washington, until late in the spring of 1889. In the settling up of the affairs of the exhibit, after the close of the exposition, much work was also required of several of those who had been connected with it, even after they had been reassigned to the Division of Fisheries. This made it necessary to do a large amount of work at night.

INQUIRY CONCERNING THE GRAMPUS.

The relations of the division to the schooner *Grampus* during the year have been very intimate and seem to deserve special mention. As soon as the Fish Commission exhibit was properly installed at Cincinnati and in good working order, I left that city on August 2, in compliance with orders from the Commissioner, and proceeded to Gloucester, Mass., where the *Grampus* was then lying. The vessel had been at Gloucester more than a month, the commanding officer being absent on sick leave. It was important that she should be put in order for service and that some one should be employed to take command of her temporarily, until such time as it was believed Capt. D. E. Collins might be able again to resume charge of the vessel.

Acting under the authority of the Commissioner, I had certain repairs made to the vessel and she was put in first-class order for sea service. I also engaged Capt. George H. Martin to take command of the *Grampus*, after which the vessel sailed for Wood's Holl. I went on her and made several trips from Wood's Holl, in order to familiarize Capt. Martin with the routine and general work prosecuted by the schooner. Early in September I left Wood's Holl and returned to Cincinnati via Washington, where I spent a few days to look after affairs in the office of the division.

Early in November, and shortly after my return to Washington from Cincinnati, I was ordered to Gloucester, Mass., on special duty. On November 16, 1888, the Commissioner telegraphed the information that the *Grampus* was ashore on Bass Rip, Nantucket Shoals, and directed me to take such measures as seemed necessary to rescue the vesssel, etc.

It may be stated that the vessel went ashore on Bass Rip on the morning of November 15, and was abandoned that evening, the wind at the time blowing a moderate gale, with indications of the approach of a heavy storm. The vessel drifted off the shoal after being abandoned, and several days later was picked up and brought into Wood's Holl. Before her arrival I was directed by the Commissioner to make

an official investigation of all matters connected with her stranding and abandonment, and after her return I was ordered to continue the inquiry, including such testimony as could be obtained respecting her rescue, etc. I was also ordered to assume charge of the vessel for the time being and take her to Gloucester, Mass., and have such repairs made as seemed to be necessary; likewise to employ a captain to take charge of her when she was ready, and to enlist a crew.

This duty, which, as has been stated, began November 16, was not completed until after the middle of January, though the work was pushed with all possible vigor. I reported in Washington, January 21, 1889, and after my arrival there an exhaustive report was compiled, embracing all the testimony and other data relating to the stranding, abandonment, etc., of the vessel.

Circumstances over which the writer had no control prevented the preparation of the reports on the construction and equipment of the *Grampus* and on her work for the fiscal year ending June 30, 1888, until the latter part of the present year. As soon as it was feasible to do so, the compilation of these reports was undertaken and pushed forward as rapidly as possible. At the close of the year both were in an advanced stage of completion, though it is proper to say that the time and labor devoted to them have necessarily obstructed the expansion of the division work in some other directions.

INDEX TO REPORT OF COMMISSIONER.

APPENDICES.

1.—REPORT ON THE FISHERIES OF THE PACIFIC COAST OF THE UNITED STATES.

By J. W. Collins.

I.—INTRODUCTION.

1. HISTORY OF THE INVESTIGATION.

Among the matters that specially engaged the attention of the Commissioner, Hon. Marshall McDonald, immediately after his appointment in 1888, and one which was deemed very important, was the prosecution of an inquiry having for its object the collection of statistics and other data relating to the commercial aspects of the river, shore, and sea fisheries of the Pacific coast of the United States, exclusive of Alaska. This was part of a general plan for a thorough investigation of all matters relating to the western fisheries. The *Albatross* had been dispatched to the Pacific the previous autumn for the purpose of making a careful survey of sea fishing grounds and carrying on other scientific researches of importance to the fishery interests. She entered upon her work in the summer of 1888, and it was intended that the inquiry respecting the extent and value of the fisheries, etc., should be prosecuted contemporaneously with the researches at sea. Unforeseen circumstances, however, delayed the immediate inauguration of the inquiry as originally planned.

It was the intention of the Commissioner that I should make a preliminary reconnoissance of the west coast fisheries in the spring and early summer of 1888, and preparation had been made for the trip, when circumstances rendered it necessary for him to order me to Washington to assume more responsible duties.

The organization of the Division of Fisheries, the conduct of important inquiries concerning the fisheries of other regions, and my connection with the exhibit of the Fish Commission at the Centennial Exposition held at Cincinnati in the summer and autumn of 1888, made it entirely impracticable to undertake the investigation of the Pacific fisheries until near the close of the year.

On November 15, 1888, Mr. W. A. Wilcox was assigned to the duty of making the inquiry, and he immediately began work at San Francisco. Later he went to San Diego and, beginning there, traveled north to Puget Sound, visiting nearly all the fishing stations along the coast and on the rivers. In some instances he was able to secure all necessary information for certain regions from parties carrying on the fisheries there, but who were met elsewhere. In these cases no advantage would have accrued from visiting the localities omitted, because they were generally in remote places difficult of access, and since it was then out of the fishing season the canneries were closed; besides, no one else could give such reliable information concerning the fisheries at those points as the parties interviewed. With few exceptions, however, the various fishing centers, rivers, bays, etc., were visited during the height of the season, when the conditions and methods of fishery could be observed under the most favorable auspices.

Many difficulties were encountered in prosecuting the inquiry, and it became necessary to go over much of the region twice. Fisheries situated away from the ordinary lines of communication had to be reached by primitive methods of travel, and the utmost tact was required in some cases to secure necessary information from suspicious Chinese, or others having only an imperfect knowledge of the English language, and whose interest in the fishing industry goes no further than the pittance it supplies them. Though instances of this kind were exceptional, they were occasionally almost insurmountable obstacles to obtaining a full knowledge of the fisheries.

An important phase of this inquiry has been the examination of the commercial fisheries of the small streams, bays, and harbors along the coast, many of which had not previously been investigated.

The canvass made by Mr. Wilcox closed on September 23, 1889, when he was ordered to other duty. Subsequently, during the winter of 1889–90, it became necessary to make some additional inquiry concerning certain details of fishery, etc., at Santa Cruz, San Francisco, and the Sacramento River; the *Albatross* was then lying at Mare Island navy-yard, and Mr. A. B. Alexander, fishery expert on board that vessel, was detailed for the purpose. The notes forwarded by him contained considerable information relative to the fisheries in 1889, which, of course, it was not practicable to secure at an earlier date; this has proved valuable in the compilation of the report. He completed his work on January 7, 1890.

Although the inquiry covered 1889 in part, complete statistics were obtained only for 1888. These figures are given in the tabulated statements, while the statistical data secured for 1889 appear incidentally in the text.

As fishery expert on the *Albatross*, Mr. Alexander made studies of certain phases of the cod fishery prosecuted in Alaskan waters and of the Puget Sound fisheries, to which reference is made elsewhere.

2. SCOPE AND OBJECT OF THE REPORT.

The scope of this report is limited to a consideration of such fisheries as are prosecuted in or from the region embraced between the southern extremity of California and the northwestern limit of Washington. Incidentally, a somewhat extended reference has been made to certain phases of fishery in Alaska, in explanation of industries controlled by capitalists of San Francisco or elsewhere, and which really constitute a part of the fishing interests of the region specially treated of here. Mention has also been made of the Alaskan salmon fishery in order that the statistics of the Pacific fisheries may be as comprehensive as practicable, and that intelligent comparisons may be made of the relative productiveness of the various localities in the territory controlled by the United States.

An investigation of the salmon fisheries of Alaska was made by Dr. Tarleton H. Bean, ichthyologist of the Commission, in the summer of 1889, and a report has been prepared and published giving the results of the inquiry.

A leading object has been to make this a geographical review, so far as practicable, and the attempt has been made to localize the fisheries of each section, so that their relation to other industries and all other local conditions affecting them may be understood. An important phase of this part of the work has been the consideration of the commercial fisheries of the small streams and bays, most of which have not been previously mentioned in the reports, for the reason that many of them have attained prominence as fishing centers since any similar inquiry was undertaken. A scarcely secondary object has been to embody all leading facts concerning the history, methods, statistics, etc., of each of the more important branches of the fishery industry. Another important feature is the attempt to point out how certain fisheries may be improved or new enterprises established. Thus the knowledge gained of the conditions of the fisheries of the west coast makes it feasible to suggest, from a study of similar industries elsewhere, what should be done to secure the best results.

For lack of space it has been found impracticable to put in this report a chapter on fishing vessels and boats prepared for that purpose; that will, however, be published hereafter. For the same reason some other important matters have not been sufficiently elaborated. However, nothing vitally important to a proper presentation of the matters dealt with has been omitted.

3. SOURCES OF INFORMATION.

The chief source of information has been the inquiry prosecuted by Messrs. Wilcox and Alexander, in which the latter took only a comparatively small part. It is, however, only just to say that important studies were made by Mr. Alexander of the northwest-coast fisheries,

which have been embodied in the report made by Captain Tanner on the explorations of the *Albatross*. This report has been drawn upon for data relating to fishery methods.

The writings of Rathbun, Elliott, Bean, Jordan, and Gilbert have been valuable sources of information both as relates to methods and the definition and distribution of species. In a very few cases interesting and valuable data have been obtained through correspondence.

Through the courtesy of the transportation agencies, fish-packers, and fish-dealers, the agents of the Commission were generally able to get full and reliable data from the records of firms, corporations, etc.

4. METHODS OF TREATMENT.

In preparing this report an effort has been made to present all the useful information in the most convenient shape for reference. In some cases the fishing interests of a locality were so insignifiant that they have been disposed of in a single chapter; but in most instances the material has been arranged and classified to show all the important details. The method of treatment has been varied by necessity, so as to adapt the consideration of fisheries to existing conditions of a geographical or local nature. In California, where there are coast fisheries, it has generally been feasible to consider their relations to the various counties bordering the sea and bays. Exception to this occurs in the discussion of the fisheries of the Sacramento and San Joaquin Rivers.

The fisheries of Oregon and Washington, however, are largely confined to streams of greater or less magnitude, and the most desirable method has been to consider each river basin by itself, regardless of territorial limits. The region embracing Puget Sound, Washington Sound, the Strait of Juan de Fuca, and the Gulf of Georgia has been discussed as if it were a river basin.

The report begins in the south at San Diego, where the inquiry practically started, and each geographical section is taken in turn until the northern extremity of the coast line of Washington is reached.

Perhaps the most important matter connected with the treatment of available information relates to illustration. The maps herewith presented for the first time will prove a valuable aid in conveying a proper understanding of the fishery industries of each section, showing the fishing grounds, the location of special forms of fixed apparatus, fishing towns, canneries, etc. Other illustrations show the methods of fishing, the fishing stations, the preparation of products, etc.

5. IMPORTANCE OF THE PACIFIC FISHERIES.

The fisheries of the Pacific coast of the United States are second only in rank to those prosecuted along the Atlantic coast; several branches take precedence of all others of a similar character in the world, while others are now coming into marked prominence or have much that is promising for the future.

Among the first may be mentioned the fur-seal and salmon industries, which are unequaled elsewhere. The whale fishery has attained important proportions, and San Francisco may now fairly be considered the leading center of the whaling industry. The canning of sardines on an extensive scale, the preparation of caviare, the establishment of a mackerel fishery, an improvement in the cod fishery as the result of demand in South American markets, and an increase in the fresh-salmon trade, are important probabilities which may be fully realized within a comparatively short time if the proper effort is made to profit by existing conditions and to utilize available resources.

There has been a gratifying increase in the fisheries of the Pacific, taken as a whole, since the census of them was obtained in 1879–80, and there is reason for anticipating future advancement in certain directions, though cause exists for serious apprehension of decline in the fur-seal fishery, and possibly in one or two other branches, if present methods continue.

In illustration of the important position held by the west coast in contributing to the world's food supply, the appended tables, relating to the salmon-canning industry, may with propriety be introduced here. For purposes of comparison, and that the entire industry may be placed before the reader, the results of the business in Alaska and British Columbia are added to those of the Pacific States.

An outline of the salmon canning in 1889 is given in the following table, from which it appears that of 122 canneries in operation that year, 98 were in United States territory and 24 on British soil, and of the former 36 were in Alaska. Of the total pack, Alaska produced the largest part; and, although in the number of canneries that Territory exceeded Oregon by only one establishment, the output was more than double that of the State named, a fact due partly to the larger capacity of the Alaskan canneries, but chiefly to the greater productiveness of the Alaskan rivers.

Abstract of the salmon-canning industry of the Pacific coast of North America in 1889.

Locality.	No. of canneries.	No. of cases of salmon canned.	Value at average market price.
Alaska	36	675,000	$3,375,000
British Columbia	24	414,400	2,072,000
Washington	18	203,600	1,201,240
Oregon	35	333,113	1,965,367
California	9	75,347	452,082
Total	122	1,701,460	9,065,689

The pack of the west coast during the fourteen years ending 1889, as shown by the following table, amounted to 12,493,086 cases, with an estimated value of about $75,000,000. The weight of the salmon consumed in the preparation of this enormous pack was over 876,000,000 pounds, equivalent in point of weight to 1,000,000 head of cattle, and greatly exceeding the latter in economic importance and food value.

Annual output of the salmon canning industry of the Pacific coast of North America from 1876 *to* 1889.

Year.	Cases.	Approximate gross weight of fresh salmon utilized.
	Number.	*Pounds.*
1876	475, 600	33, 292, 000
1877	504, 800	35, 336, 000
1878	638, 000	44, 660, 000
1879	539, 600	37, 772, 000
1880	679, 500	47, 565, 000
1881	911, 100	63, 777, 000
1882	994, 800	69, 636, 000
1883	1, 106, 600	77, 462, 000
1884	985, 295	68, 970, 650
1885	835, 715	60, 400, 050
1886	933, 354	65, 334, 780
1887	997, 890	69, 852, 300
1888	1, 189, 372	83, 256, 040
1889	1, 701, 460	119, 102, 200
Total	12, 493, 086	876, 416, 020

Although of only about 7 years' existence, the salmon-canning industry of Alaska has become more important than that of any other region. The increase in growth during the past few years has been phenomenal, especially in 1889, when the pack of 675,000 cases represented an increase of 377,000 cases over the previous year. How long the supply of salmon can keep up under this enormous drain can not be predicted, but it would seem that in any event Alaska is to be the great salmon region of the future. The yearly increase is shown in the table:

The Alaska salmon pack from 1883 *to* 1889.

Year.	Number of cases.	Year.	Number of cases.
1883	36, 000	1887	190, 200
1884	45, 000	1888	298, 000
1885	74, 850	1889	675, 000
1886	120, 700		

The importance of British Columbia as a salmon-producing and salmon-canning country may be seen in the following summary, covering 14 years. As in Alaska, there was a large increase in the output in 1889, independently of an increase in the number of canneries.

Number of salmon canneries in operation in British Columbia from 1876 *to* 1889, *and the annual output of canned salmon.*

Year.	No. of canneries.	No. of cases canned.	Year.	No. of canneries.	No. of cases canned.
1876	3	9, 847	1883	24	196, 292
1877	6	67, 387	1884	17	141, 242
1878	10	113, 601	1885	9	108, 517
1879	9	61, 093	1886	17	161, 264
1880	9	61, 849	1887	20	204, 083
1881	12	177, 276	1888	21	186, 663
1882	18	255, 061	1889	24	414, 400

An examination of the table exhibiting the extent of the export and shipping trade in canned salmon shows that more than one-half of the total pack in 1889 was sold in Europe, and about one-fifth of the pack was consigned to the Eastern States. The entire export trade of British Columbia is with the mother country, to which the Columbia River also sends all that portion of the pack not shipped to points in the United States. San Francisco likewise has a large trade with England; it also exports considerable quantities of canned salmon to Australia and makes smaller shipments to numerous other countries.

It will be noticed that the record of shipments falls considerably below the total amount packed. This is due chiefly to the fact that account has only been taken of the important shipments to the Eastern States, while the local consumption of Canada and other British provinces, as well as that of the Western States, has not been included. The main object of this table is to show the general drift of the Pacific coast trade in canned salmon.

Shipments of canned salmon by rail and water in 1889.

Whence and where sent.	No. of cases shipped by rail.	No. of cases exported by vessels.	Total.
British Columbia:			
To London	....	175,843	175,843
To Liverpool	....	158,686	158,686
Total	....	334,529	334,529
Columbia River:			
To London	....	26,605	26,605
To Liverpool	....	100,885	100,885
To Eastern States	212,757	....	212,757
Total	212,757	127,490	340,247
San Francisco:*			
To Australia	....	80,141	80,141
To London	....	85,084	85,084
To Liverpool	....	263,031	263,031
To Hamburg	....	500	500
To the Orient	....	3,392	3,392
To Pacific islands	....	4,191	4,191
To Spanish America	....	1,031	1,031
To Eastern States	110,498	41,753	152,251
Total	110,498	479,123	589,621
Grand total	323,255	941,142	1,264,397

* So far as could be ascertained the following localities were represented to the extent given in the exports of canned salmon from San Francisco to European ports: Alaska, 209,678 cases; Columbia River, 9,374 cases; Sacramento River, 15,624 cases; other United States rivers, 22,438 cases; British Columbia, 49,140 cases; unknown, 42,361 cases.

6. REMARKS ON FISHING GROUNDS, ETC.

As a rule the location, designation, outline, and description of the shore fishing grounds, including those in bays and rivers, have been based on information furnished by the fishermen who daily work upon them, or by others familiar with the facts. In many cases, however, it was practicable for the agents of the Commission to visit the fishing

grounds, more particularly those on the bays and rivers, and from actual observation to mark definitely on the charts the location and extent of fishing areas. At the same time the leading characteristics of the different localities were noted, including the kinds and quantities of various species of fish or other aquatic animals that occur in each section in different seasons. The notes on the distant sea fishing grounds have been compiled from various sources, most of the information, however, being the result of investigation by the U. S. Fish Commission.

In a large majority of cases no attempt has been made to define the limits and contour of the fishing grounds, except to show the areas actually utilized by the fishermen. In the greater number of instances the regions off the coast thus marked are smaller in extent than would appear from actual surveys, taking a certain depth as a basis of limitation. In a few cases, notably about the Farallone Islands, the area said to be frequented by the fishermen is larger than might be supposed if one were guided only by the relative depth of water. Those familiar with fisheries will readily comprehend how these apparent discrepancies must appear when the object is simply and only to show approximately those regions which are commercially important as fish-producing areas. It is confidently believed that all fishing grounds of commercial importance have been shown which come within the scope of the maps. Care has been taken to designate the extent and location of all areas where oysters, clams, and other valuable mollusks occur in considerable abundance.

A specially important feature is the location and designation of fixed apparatus, such as pound nets, weirs, traps, fish-wheels, etc., on the coast and in the rivers and bays, besides which the seine-reaches have been defined, and in many other ways the apparatus chiefly used on certain fishing grounds has been shown.

7. ARTIFICIAL PROPAGATION AND ACCLIMATIZATION.*

No section of the country is probably more dependent on fish-culture for the successful continuance of its fisheries than the Pacific slope. Experience has fully demonstrated that the supply of salmon is likely to be so much reduced through overfishing that the industry depending upon their capture must soon be abandoned, unless the skill and well directed efforts of man are utilized to maintain the stock upon which he draws so heavily and so continuously. Artificial propagation of fish has now passed beyond the experimental stage, and there is no longer doubt in unprejudiced and well-informed minds as to its possi-

* While the results of artificial propagation of food-fishes on the west coast and the introduction of Atlantic species in the waters thereof are subjects germane to the objects of this review, the space allotted precludes extensive discussion here. It is intended, however, to fully discuss this work in an article on the results of artificial propagation which the Commissioner now has in contemplation.

bilities when conducted intelligently and on a scale equal to the objects aimed at. It is believed by those competent to speak on the subject that the artificial propagation of salmon has been very beneficial of late on the Columbia River, although the hatchery on the Clackamas has not been long established and the magnitude of its operations has not, until quite recently, been commensurate with the important interests at stake.

One of the best illustrations of the effect of fish-culture in the waters of the west coast is found at Rogue River. Here, for several years, the proprietor of the fishery at Ellensburgh, Mr. R. D. Hume, has been accustomed to have a private hatchery. Salmon were kept in confinement until ready to spawn, when their eggs were taken and treated essentially as they are handled at other hatcheries. Every year more or less fry were put into the river. This has resulted in a continuous and gratifying increase in the abundance of salmon in the Rogue River from the first season when the effect of artificial propagation was observed, which was about four years after fry were first hatched out at Ellensburgh. Thus the pack of canned salmon on this river has been more than doubled in a few years, due entirely to the increase in the abundance of fish. The supposition is that salmon would have continued to grow scarce in the river, as was observed before artificial fish-hatching was resorted to, until the supply became so much reduced that packing them would no longer have been profitable. It is a remarkable fact that Rogue River is the only stream on the Pacific slope which has shown an increase in the number of salmon entering it; a result, however, that has only been noticeable since artificial propagation was begun there.

The acclimatization or introduction of certain species into Pacific coast waters has been a most important matter. Among those so introduced are the shad (*Clupea sapidissima*) and striped bass (*Roccus lineatus*), two of the most delicious food species of the Atlantic region, and both anadromous. The shad is now widely distributed along the coast, and promises to become abundant in time. It is reputed to have changed its habits somewhat on the west coast because of local conditions; instead of returning to the sea as soon as it has spawned in the rivers, as is its habit in eastern waters, some observers say it seldom enters the ocean, or at least does not go far, because of the cold waters of the Humboldt stream that sweep in along the coast; it remains in the warmer waters of the estuaries and bays, and is taken at nearly all seasons.

The striped bass is beginning to figure conspicuously in the markets; the newspapers occasionally notice the capture of large specimens, and there is reason to anticipate that it will attain prominence in time.

The carp has increased greatly in numbers, and is a very common species in San Francisco and some other places.

Among the recent efforts of the United States Fish Commission to introduce new species into Western waters has been the attempt to plant the Atlantic lobster (*Homarus americanus*) in the Pacific. This

proved completely successful. In 1888 565 adult lobsters and 104,000 fry were planted off the coast in localities deemed most suitable for them. What the result of this will be can be conjectured, but can not be definitely determined until after the lapse of sufficient time to give the lobsters an opportunity to grow and multiply.*

8. COMPARISON OF THE FISHERIES OF THE PACIFIC STATES.

There is considerable variation in the fishing interests of the three Pacific Coast States both as relates to their character and their value. In order that the opportunity may be presented for an easy comparison of their respective importance the following tables are produced here:

Persons employed in the fisheries of the Pacific States in 1888.

States.	Fishermen.		Shoresmen and factory hands.	Total.
	On vessels.	On boats.		
California	*1,543	3,188	607	5,338
Oregon	53	3,045	1,584	4,682
Washington	283	2,571	976	3,830
Total	1,879	8,804	3,167	13,850

* Not including 753 men employed on whaling vessels belonging at New Bedford, Massachusetts, and making their headquarters at San Francisco.

Apparatus and capital employed in the fisheries of the Pacific States in 1888.

States.	Apparatus of capture.											
	Gill nets.		Seines.		Trammel nets.		Trap nets, pound nets, and weirs.		Salmon wheels.		Value of minor apparatus.	Total Value.
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.		
California	2,367	$256,465	1,629	$57,625	329	$14,735	....	....	....	....	$28,850	$317,175
Oregon	2,545	322,620	25	7,260	....	....	56	$41,550	24	$63,613	2,900	437,943
Washington	1,130	187,345	59	44,200	....	....	159	122,400	15	45,287	2,945	402,177
Total	6,042	766,430	1,713	109,085	329	14,735	215	163,950	39	108,900	31,695	1,157,295

States.	Vessels.				Boats.		Other property.		Total capital invested.
	No.	Net tonnage.	Value.	Value of outfit.	No.	Value.	Value of wharves, buildings, and accessories.	Cash capital.	
California	94	12,108.81	$1,046,500	$447,475	1,354	$245,010	$323,050	$267,500	$2,684,210
Oregon	13	422.30	74,050	11,400	1,545	201,095	619,294	952,850	2,296,632
Washington	17	752.73	71,600	31,520	1,202	145,880	333,220	533,000	1,517,397
Total	124	13,283.84	1,192,150	490,395	4,101	591,985	1,275,564	1,753,350	6,498,239

* For a detailed history of the transplanting of lobsters to Pacific waters, reference is made to a paper by Mr. Richard Rathbun, in the Bulletin of the U. S. Fish Commission, vol. VIII, 1888, p. 453.

Products of the fisheries of the Pacific States in 1888.

Species.	California.		Oregon.		Washington.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Fish.								
Salmon, fresh * . . lbs.	8, 024, 035	$392, 335	23, 415, 242	$963, 616	16, 185, 836	$681, 808	47, 625, 113	$2, 037, 759
Salmon, pickled . lbs	515, 000	18, 650	532, 900	21, 595	133, 900	4, 805	1, 181, 800	45, 050
Shad, fresh . . . . . lbs	90, 871	6, 513	10, 000	500	200	50	101, 071	7, 063
Other fish, fresh . lbs.	9, 735, 726	543, 458	1, 009, 924	20, 658	2, 294, 400	66, 345	13, 040, 050	630, 461
Other fish, pickled and dried . . . . . lbs.	4, 947, 692	130, 442	201, 200	4, 474	300, 000	10, 100	5, 448, 892	145, 016
Total	23, 313, 324	1, 091, 398	25, 169, 266	1, 010, 843	18, 914, 336	763, 108	67, 396, 926	2, 865, 349
Mammals.								
Fur seal, sea otter, walrus, hair seal, and sea lion pelts . . . . No	†107, 913	1, 799, 644	. . . .	. . . .	5, 381	32, 908	113, 294	1, 832, 552
Ivory and whalebone . . . . lbs.	197, 060	585, 895	. . . .	. . . .	. . . .	. . . . . .	197, 060	585, 895
Whale and seal oil . . . . galls.	292, 209	104, 834	. . . .	. . . .	. . . .	. . . . . .	292, 209	104, 834
Total	. . . .	2, 490, 373	. . . .	. . . .	. . . .	32, 908	. . . .	2, 523, 281
Mollusks and crustaceans.								
Oysters . . . . bushels.	130, 000	509, 175	4, 125	6, 250	60, 993	86, 574	195, 118	601, 999
Other mollusks . lbs.	6, 246, 335	170, 480	561, 600	7, 325	300, 000	3, 200	7, 107, 935	181, 005
Crabs, shrimp, crayfish, and prawn . lbs	5, 363, 420	186, 883	1, 194	716	6, 875	1, 070	5, 371, 489	188, 669
Total	. . . .	866, 538	. . . .	14, 291	. . . .	90, 844	. . . .	971, 673
Miscellaneous.								
Reptiles, fish oil, fertilizer, caviare, etc.	. . . .	15, 060	. . . .	8, 440	. . . .	4, 000	. . . .	27, 500
Grand total	. . . .	4, 463, 369	. . . .	1, 033, 574	. . . .	890, 860	. . . .	6, 387, 803

* Including those subsequently canned.
† These include the fur-seal skins taken at the Pribilof Islands, in Bering Sea, which are a product of a fishery carried on by San Francisco capital.

Summary of the salmon-canning industry of the Pacific States in 1888.

States.	No. of canneries.	No. of factory hands.	Salmon used for canning.		Canned salmon placed on market.	
			Pounds.	Price paid to fishermen.	Cases.	Value.
California	8	360	4, 933, 655	$245, 683	74, 822	$464, 232
Oregon	34	1, 584	21, 390, 648	889, 772	320, 822	1, 901, 617
Washington	21	976	15, 307, 920	647, 772	226, 393	1, 337, 989
Total	63	2, 920	41, 632, 223	1, 783, 227	622, 037	3, 703, 838

9. COMPARISONS WITH 1880.

One of the most interesting and instructive results of the systematic collection of fishery statistics is the institution of comparisons whereby the relative status of these industries in past and present years may be intelligently considered, and the changes noted, whether for better or worse. For the purpose of presenting in as compact form as possible the comparative statistics for 1880 and 1888, the following tables have been prepared. These show at a glance the changes between those two periods.

Comparative tables for the years 1880 *and* 1888, *showing the extent of the fisheries of the Pacific States.**

1. PERSONS EMPLOYED.

States.	Fishermen.		Shoresmen.		Total.	
	1880.	1888.	1880.	1888.	1880.	1888.
California	2, 089	4, 731	1, 005	607	3, 094	5, 338
Oregon	2, 795	3, 098	4, 040	1, 584	6, 835	4, 682
Washington	729	2, 854	15	976	744	3, 830
Total	5, 613	10, 683	5, 060	3, 167	10, 673	13, 850

2. APPARATUS AND CAPITAL.

States.	Vessels. No.		Vessels. Value.		Value of apparatus and outfit.		Cash capital and value of shore property.	
	1880.	1888.	1880.	1888.	1880.	1888.	1880.	1888.
California	49	94	$535, 350	$1, 046, 500	$205, 840	$802, 150	$307, 000	$590, 550
Oregon	......	13	... .	74, 050	245, 750	449, 343	639, 000	1, 572, 144
Washington	7	17	11, 100	71, 600	8, 648	433, 697	4, 000	866, 220
Total	56	124	546, 450	1, 192, 150	460, 238	1, 685, 190	950, 000	3, 028, 914

States.	Boats. No.		Boats. Value.		Total investment.	
	1880.	1888.	1880.	1888.	1880.	1888.
California	853	1, 354	$91, 485	$245, 010	$1, 139, 675	$2, 684, 210
Oregon	1, 360	1, 545	246, 600	201, 095	1, 131, 350	2, 296, 632
Washington	334	1, 202	6, 610	145, 880	30, 358	1, 517, 397
Total	2, 547	4, 101	344, 695	591, 985	2, 301, 383	6, 498, 239

3. RESULTS OF THE FISHERIES.

States.	Fish. 1880.		Fish. 1888.	
	Pounds.	Value.	Pounds.	Value.
California	24, 577, 920	$750, 961	23, 313, 324	$1, 091, 398
Oregon	39, 500, 000	855, 302	25, 169, 266	1, 010, 843
Washington	5, 707, 000	96, 520	18, 914, 336	763, 108
Total	69, 784, 920	1, 702, 783	67, 576, 926	2, 865, 349

States.	Value of whale, walrus, seal, and sea-otter products.		Value of crustaceans and mollusks.		Value of other miscellaneous products.		Total value of fishery products.	
	1880.	1888.	1880.	1888.	1880.	1888.	1880.	1888.
California	†$2, 289, 900	†$2, 490, 373	$194, 608	$866, 538	$3, 500	$15, 060	$3, 238, 969	$4, 463, 369
Oregon	4, 300	....	....	14, 291	10, 000	8, 440	869, 602	1, 033, 574
Washington	58, 912	32, 908	10, 000	90, 844	2, 500	4, 000	167, 932	890. 860
Total	2, 353, 112	2, 523, 281	204, 608	971, 673	16, 000	27, 500	4, 276, 503	6, 387, 603

* It would appear that the figures for Washington for 1880, taken from the *Fisheries and Fishery Industries of the United States*, section II, do not include the fisheries of that Territory prosecuted on the Columbia River. It is probable that the entire fishery industry of that river has been credited to Oregon, which fact should be borne in mind in noting comparisons between 1880 and 1888.

† Including the fur-seal and sea-otter fisheries of Alaska that are prosecuted by California capital.

10. SUGGESTIONS.

In studying the various phases of the west coast fisheries, and having in mind the condition, methods, etc., of similar industries elsewhere, it seems proper to offer some suggestions which may prove timely and helpful. In taking this action I am not insensible to the responsibility incurred, nor is there lack of appreciation of the disadvantage I labor under in not having had the opportunity to personally inspect the condition of the Pacific fisheries. Nevertheless, it seems eminently desirable that attention should be called to the following matters:

Improvements in fishing vessels and boats.—In no other direction, perhaps, can certain fisheries be benefited to a greater extent than by the introduction of improved types of vessels and boats. Small, properly rigged auxiliary steam vessels of suitable model can be much more advantageously used than sailing craft in many of the fisheries on the Pacific. It is true that small steam schooners are now employed, but the schooner rig seems rather unhandy for a steamer, and from all the information obtainable the form of these vessels is not the best that could be devised.

In no other branch of the fisheries is a change in vessels and boats apparently so much needed as in the market fishery. Reference is made to this in discussing the market fishery of San Francisco and other places farther south. There is a general need of the adoption of welled boats, in which fish, crustaceans, etc., can be kept alive until they are brought to market, and the day may not be far distant when welled steamers may be profitably employed. In a country where ice is scarce and costly, it is especially important that every improvement should be utilized which will result in placing fish products upon the market in the best possible condition at the least expenditure. The use of steam smacks is not exactly an experiment, since vessels of this description are now employed to bring fares of live halibut from Iceland to England. Perhaps the time has not yet arrived when the demand for fresh fish in Pacific ports is sufficient to warrant the employment of steam welled vessels, but it is well known that sailing smacks can be used without any increase of expenditure, while the advantage of being able to offer live fish for sale might be very great.

The mackerel fishery.—At present there seems to be an opportunity for the establishment of a mackerel fishery on the coast of California south of Monterey. There is a remarkable consensus of statement as to the moderate abundance of the bull's-eye mackerel (*Scomber colias*) along the California coast, and it would seem to be entirely feasible to make catches with comparatively small outlay for vessels and equipment. The common mackerel (*S. scombrus*) is now exceptionally scarce in the western Atlantic and perhaps may not be abundant for a series of years. In the meantime, the demand for salt mackerel is partially supplied by importations from foreign countries, and large quantities of fresh fish of this species are also brought from

Canada at considerable expense. It is therefore important that this demand should be supplied, so far as practicable, by the products of American fisheries.

If the proper methods are adopted, it may be feasible to bring quantities of the bull's-eye mackerel from the west coast to the markets of the Central States, and even as far as the Atlantic coast. A profitable business might be inaugurated by canning mackerel in this region if the supply is sufficient to warrant the attempt and the quality of the fish is suitable for packing in this manner.

Atka mackerel.—The Atka mackerel, or yellow-fish (*Pleurogrammus monopterygius*), occurs in considerable numbers in the western part of the Aleutian archipelago, about Atka and Attu Islands, during May, June, and July. Usually it arrives about the middle of May and remains until toward the latter part of July. It is said that this is a most delicious species, and would be a very excellent substitute for the common mackerel. It is also believed that it may be readily taken in considerable numbers by hook-and-line fishing. The natives secure considerable quantities in the season, by spearing.

Mr. L. M. Turner, who visited Atka Island in 1879, found that fish of this species arrived "in countless thousands" about the 18th of June. He says that they generally head the tide, which rushes with great velocity through the pass, the fish varying their position as the current changes. He observed that the spawning season is generally over as early as the 20th of July, after which the fish gradually disperse and return to the deeper waters of the Pacific.

The following remarks by Mr. Turner are from his "Contributions to the Natural History of Alaska":

> The fish arrive at Attu, from the southwestward, about the 24th of April, though this date varies according to the openness of the season. It is rarely later than the 1st of May. The fish come at first in a straggling manner, and their first appearance is made known by their being caught on hooks while the men are fishing for other kinds. The first-comers are usually adult males. They are not fat on arrival, but soon become so from the abundance of small crustaceans that fairly swarm among the patches of seaweed by the 10th of May, and at which time the fish are tolerably numerous. By the 10th of June thousands of these fish can be seen in the shallow water (about 1½ to 8 fathoms deep) below. The natives here take considerable quantities of these fish, and dry them for use at an early date. * * * When they go to catch them they visit the various localities known to be the haunts of these fish, and by looking beneath the mass of kelp fronds can see them if present; if not, the fish are off in the open water.
>
> * * * * * * *
>
> I here had opportunity to come to the conclusion that these fish will bite readily at the hook. I saw them jump and struggle to get at the gaff and could feel them strike against it while it was in the water, and at times it was impossible to hold it in position, as the mass of moving fish carried it along with them. Any kind of fresh fish may be used as bait on a small cod-hook for these fish. A piece of scarlet flannel tied above the hook is good to attract the fish, as they will then bite voraciously. With the hook a person can catch the fish as fast as put into the water. With the use of several hooks on one line several fish may be taken at once. With the gaff the fish are taken in great quantities, equal to all demands. The run lasts at Attu until July 25, after which the fish are spent and slowly disappear from the waters.

These fish were not known at Attu previous to 1875. They came unexpectedly and were caught on hooks set for other fish. Since that time the people have had an abundance of them. From my own observations I am led to assert that 500 barrels of 200 pounds each can be procured at Attu in the season from June 1 to July 31.* At the entrance to Chicagof Harbor is the only known locality at Attu where these fish resort. These fish are also reported to be abundant at Kiska Island, between the islands of Atka and Athákh; also between Unálga and Unalaska, and also in the passes between some of the Shumagin Islands. I saw a few individuals in Captain's Harbor, Unalaska Island, in the early part of July, 1881. This is the first instance of their occurrence in that locality. * * * They can be prepared at a cost of $2 per barrel for the fish at either Attu or Amlia. The cost of the barrel and salt, of course, is to be added. Only the necessary sheds for protecting the barrels from the weather would have to be erected. Native help could be procured at a cost of $1 per day for a man, and 50 to 75 cents per day for the women, who can clean the fish as expertly as the men. Ere many years these fish will command a highly remunerative price to those who will engage in the enterprise.

It is a matter of regret that no well-directed effort has been made by white men to capture this species in quantities by hook and line. In the summer of 1889 Captain Jacobs reported that he went to Atka in the schooner *Mollie Adams* and made a special effort to catch the yellow-fish by the use of a purse seine. The habit of the species, however, which impels it to frequent shallow water, particularly where the giant kelp grows in abundance, rendered nugatory all attempts to catch it by seining. I am not informed that he made any endeavor to secure it by fishing with hook and line.

Freezing-houses.—The importance to the fishing interests on the Pacific coast of the establishment of properly constructed freezing-houses can hardly be overestimated. The demand for fresh fish in all parts of the country is a growing one, and apparently increases more rapidly than the population. This demand should be met and all legitimate means should be employed to increase it. Among the methods so far adopted for the preservation and distribution of fishery products, none perhaps has met with greater or more deserved favor than that of artificially freezing many species of fish which can be satisfactorily kept in this manner and distributed through the means of refrigerator cars over an enormous extent of territory. In the matter of supplying the demand for salmon, the Pacific region unquestionably has an advantage, and one that it is believed will be maintained if all available resources are utilized. It will doubtless be found that a greater amount of money will be realized if a larger percentage of the products of the salmon fishery can be disposed of in a fresh condition instead of being canned. And this additional advantage will accrue: that the quantity of salmon consumed will be much larger than heretofore, which must manifestly be to the profit of the producer.

It is probable that freezing-houses might be profitably utilized to advance the demand for and distribution of many species of fish besides

* The statement that 500 barrels of Atka mackerel could be taken at Attu in a single season, probably refers to what Mr. Turner believes might be secured from the natives.

those belonging to the salmon family. Allusion has been made, in the body of the report, to what has been accomplished on the Columbia River in the case of the sturgeon, and there seems to be no good reason why similar results may not be attained in other directions.

Halibut may some time become an important factor in the fresh-fish trade of the west coast; and it is worth while to call attention to the fact that this species can not be successfully handled in a frozen state. It might prove advantageous to have the means of keeping it in a temperature a trifle above freezing, but when frozen its flesh becomes so flabby and flavorless as to render it practically unfit for food.

Artificial ice.—The difficulty of obtaining natural ice throughout the region embraced within the scope of this report, namely, from San Diego to Puget Sound, is a serious drawback upon the market fishery. As it is entirely feasible at present to manufacture ice at a moderate cost, plants for this purpose should be established at a few of the fishing centers along the coast. This is an enterprise in which the fishing interest itself should be concerned, that it may not be subjected to overcharges for ice. The extent of the market fishery and market trade of San Francisco would seem to warrant the establishment of a plant capable of furnishing all the ice required in the fish trade of that city, and perhaps even to supply fishing stations near it. Astoria, Portland, and Seattle would seem to be other points where the manufacture of ice may be made profitable.

Canning of halibut.—It seems possible that canned halibut might be introduced in the markets of the United States or other countries. In view of the comparative cheapness of the raw material on Puget Sound, it might be worth while for parties interested in canneries there to pack a few cases, in order to introduce this article of food in the markets of the world.

Markets for cod, etc.—In the chapter on the cod fishery, attention has been called to the possibility of establishing new markets in South American countries, and also to the feasibility of curing cod in a special manner for exportation. It is not necessary to discuss this matter at length here, but simply to refer to suggestions made elsewhere.

Handling market fish.—No matter connected with the fishery of the west coast seems to demand more earnest attention than the subject of properly caring for and distributing fresh-fish products. Attention has been called to this in the chapter on the market fishery of San Francisco, and the remarks made there are believed to be equally applicable to many places on the Pacific, where fish are sold in a fresh condition. There can be no question that it will be to the advantage of producers and consumers alike if the most improved methods are adopted and the most intelligent care is exercised in the matter of marketing the products sold for daily consumption. It seems pertinent to say that nothing improves the quality of fish more than to kill them by a blow immediately after they are caught, and, if practicable, to

bleed them. This method can be very readily applied to fish of any considerable size, and it will add immensely to the firmness of flesh and its flavor as an article of food.

Utilization of waste products.—There seems to be an opportunity in some of the larger fishery centers to profitably utilize the waste products, and thus add considerably to the returns now obtained from fishing. In the discussion on the Columbia River fisheries, mention is made of a small establishment at Astoria which has handled waste products to a limited extent; much more might be done in that direction on the Columbia River, and considerable quantities of material might be utilized at San Francisco which are now thrown away. A ready demand could be found in farming communities for all fertilizers manufactured from waste products of the fisheries. Large quantities of sturgeon and other fishes are now thrown into the Columbia River, to decay and to pollute the waters, which ought to be applied to food purposes or in some other way for the benefit of mankind. This matter deserves the earnest consideration of all interested in fishing; for whatever the conditions may be to-day, the time is not far distant when the results of such wasteful destruction will be too apparent.

Transportation, etc.—The question of transportation is important, and may well engage the consideration of all having the welfare of the fisheries at heart. It appears that while the transportation agencies of the West, as a rule, are disposed to deal fairly with shippers of fish, it is nevertheless true that freight charges are a serious burden and may limit the distribution of perishable products. The value of the fish trade to the prosperity of the railroads is doubtless understood, but the full importance may not be realized. It is probable, however, that the intelligence which controls transportation agencies will lead to the adoption of a fairly liberal policy, and that concessions will be made to the advantage of the fishing interests, which will promote their increase and development.

Under the head of the halibut fishery of Puget Sound, reference has been made to the advantages that might be secured by having centers of distribution in the great cities of the Central States. It may be to the advantage of the transportation interests, as well as the fisheries, to aid in securing the facilities referred to.

The importance of the fish trade to the development of transportation facilities has been exemplified in many instances and in various countries. In England the important city of Grimsby, at the mouth of the Humber River, has been practically built up to its present magnitude through the efforts of a railroad company, which built docks for the accommodation of fishing fleets, and found its return in carrying the products to markets.

11. ACKNOWLEDGMENTS.

I take pleasure in acknowledging courtesies and assistance received from the following parties:

The U. S. Coast and Geodetic Survey has furnished charts upon which annotations of fishing grounds, etc., were made, and which served as a basis for the maps accompanying this report.

The Fish Commission is under obligation to the various custom-house officials on the Pacific coast for courtesies rendered to statistical agents.

I desire to acknowledge in an especial manner the courtesies extended to Fish Commission officials by the transportation agencies, fish-dealers, canners, and others connected with the fishing business of the Pacific slope. The intelligent, appreciative interest shown by many gentlemen in placing their records at the disposal of the Commission made it possible to obtain accurate data in numerous instances where reliable returns could not otherwise have been secured. The agents of the Commission were frequently transported free of charge, and their work facilitated by the generous action of the parties referred to.

In the preparation of the report, particularly of the statistical tables, I have received much valuable assistance from Messrs. H. M. Smith and E. C. Bryan.

The maps have mostly been made, under my direction, by Mr. C. E. Gorham; the other drawings for illustration have been prepared by Messrs. C. B. Hudson and A. H. Baldwin.


U S Commission of Fish and Fisheries
M. McDonald Commissioner
CHART OF THE
PACIFIC COAST
FROM
SAN DIEGO TO PT. BUCHON, CAL.
SHOWING THE
COAST FISHING GROUNDS.
SEASON OF 1888-89
Crawfish ground indicated thus v v
Sea otter " " ◊ ◊
SAN LUIS OBISPO
SANTA BARBARA
VENTURA
LOS ANGELES
SAN DIEGO
CALIFORNIA
PACIFIC OCEAN
Pt. Sal
Pt. Arguello
Pt. Concepcion
CRAWFISH GROUNDS
Santa Barbara
San Buenaventura
SANTA BARBARA CHANNEL
TROLLING GROUNDS FOR BARRACUDA AND BONITO
SANTA ROSA I.
SANTA CRUZ I.
Pt. Dume
Santa Monica
SANTA MONICA BAY
Wilmington
San Pedro
SAN PEDRO CHANNEL
TROLLING GROUNDS
Santa Barbara
SANTA CATALINA
GULF OF SANTA CATALINA
SAN CLEMENTE I.
Tanner Bank
Cortez Bank
SAN DIEGO

II.—THE FISHERIES OF CALIFORNIA.

12. GENERAL REMARKS.

The fisheries prosecuted from California surpass in importance those of any other Pacific State, and in many branches rank among the foremost in the country. The vessel fisheries are particularly important, those for fur seals, sea otters, walruses, and whales being of greater extent than those of any other State. Salmon fishing is largely carried on in California, but to a less extent than in Oregon and Washington. The other market and food-fish fisheries carried on from small boats and the shore are also of great importance.

The following tabular statements, covering the year 1888, show in detail, by counties, the number and nationality of persons engaged in the fisheries; the number and value of vessels, boats, and apparatus employed; the value of shore property; the amount of cash capital; and the quantity and value of products taken:

Table of persons employed in the fisheries of California in 1888.

Locality.	Fishermen. — Vessel.	Fishermen. — Shore.	Shoresmen and factorymen.	Total.
San Diego County	88	71		159
Los Angeles County		137		137
Santa Barbara County		15		15
San Luis Obispo County		25	2	27
Monterey County	4	123		127
Santa Cruz County		25		25
San Francisco Bay and vicinity*	†1,451	1,132	250	2,833
Sacramento and San Joaquin Rivers		1,202	295	1,497
Humboldt County		388	12	400
Del Norte County		70	48	118
Total	1,543	3,188	607	5,338

*Including San Francisco, San Pablo, and Suisun Bays, and the counties of San Mateo, San Francisco, Santa Clara, Alameda, Contra Costa, Solano, Sonoma, and Marin.

† Not including 753 men employed on whaling vessels belonging at New Bedford, Massachusetts, and making their headquarters at San Francisco.

Nativity and nationality of persons employed in the fisheries of California in 1888.

Country.	Nativity.	Nationality.	Country.	Nativity.	Nationality.
United States	866	1,736	Austria	19	18
United States (Indians)	68	68	Russia	107	75
Mexico	4	4	Spain	50	46
Central America	2	2	Portugal	841	487
South America	18	18	Italy	768	516
Great Britain	236	186	Greece	32	26
France	16	14	China	934	934
Germany	145	109	Japan	29	29
Belgium	1	1	Sandwich Islands	15	13
Holland	3	3	South Sea Islands	14	12
Sweden	413	298			
Norway	129	121	Total	4,731	4,731
Denmark	21	15			

This table does not include shoresmen.

Table of apparatus and capital employed in the fisheries of California in 1888.

Locality.	Apparatus of capture.									
	Gill nets.			Trammel nets.		Seines.		Traps, pots, and fykes.		Value of hand lines, trawl lines, etc.
	No.	Length (feet).	Value.	No.	Value.	No.	Value.	No.	Value.	
San Diego County	20	5,000	$525	......	......	5	$1,600	60	$90	$200
Los Angeles County	73	18,250	2,150	......	......	12	1,635	140	210	830
Santa Barbara County	21	5,800	720	14	$560	3	300	60	120	77
San Luis Obispo County	40	12,000	2,000	......	......	......	......	......	......	925
Monterey County	80	19,000	2,400	......	......	20	3,965	......	......	533
Santa Cruz County	110	26,400	4,400	......	......	6	750	......	......	910
San Francisco Bay and vicinity	1,332	498,400	80,720	315	14,175	1,563	44,275	1,200	3,300	17,955
Sacramento and San Joaquin Rivers	504	756,000	151,200	......	......	......	......	30	700	......
Humboldt County	127	54,600	7,350	......	......	18	4,800	......	......	......
Del Norte County	60	18,000	5,000	......	......	2	300	......	......	......
Total	2,367	1,413,450	256,465	329	14,735	1,629	57,625	1,490	4,420	21,430

Locality.	Vessels and boats.						Other property.		Total capital invested.
	Vessels.				Boats.		Value of wharves, buildings, accessories, and land.	Working capital.	
	No.	Net tonnage.	Value.	Value of outfit.	No.	Value.			
San Diego County	22	277.16	$13,200	$7,300	43	$8,910	$1,000	....	$32,825
Los Angeles County	....	....	....	....	69	10,510	500	....	15,835
Santa Barbara County	....	....	....	....	24	2,375	300	....	4,452
San Luis Obispo County	....	....	....	....	19	2,500	200	....	5,625
Monterey County	1	11.00	800	100	50	8,975	500	....	17,273
Santa Cruz County	....	....	....	....	20	10,900	450	....	17,410
San Francisco Bay and vicinity	71	11,820.65	1,032,500	440,075	432	96,030	105,000	$155,000	1,989,030
Sacramento and San Joaquin Rivers	....	....	....	....	520	100,800	200,000	100,000	552,700
Humboldt County	....	....	....	....	93	1,860	1,500	2,500	18,010
Del Norte County	....	....	....	....	84	2,150	13,600	10,000	31,050
Total	94	12,108.81	1,046,500	447,475	1,354	245,010	323,050	267,500	2,684,210

Table of products of the fisheries of California in 1888.

Locality.	Fish.									
	Fresh salmon.		Fresh shad.		Other fresh fish.		Pickled salmon and dried fish.		Total.	
	Lbs.	Value.	Lbs.	Value	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
San Diego Co	....	......	......	......	630,000	$18,900	530,220	$21,209	1,160,220	$40,109
Los Angeles Co	....	......	......	......	803,838	33,140	100,000	5,000	903,838	38,140
Santa Barbara Co	....	......	......	....	90,320	4,516	6,325	316	96,645	4,832
San Luis Obispo Co	....	......	......	......	129,427	3,883	10,000	600	139,427	4,483
Monterey Co	5,000	$250	....	......	946,326	47,316	51,147	1,557	1,002,473	49,123
Santa Cruz Co	15,000	750	20,000	$1,400	200,247	9,612	....	......	235,247	11,762
San Francisco Bay and vicinity	428,000	30,200	14,000	1,120	6,282,554	402,473	4,250,000	101,760	10,974,554	535,553
Sacramento and San Joaquin Rivers	6,174,978	308,748	56,471	3,953	591,514	20,943	120,000	6,000	6,942,963	339,644
Humboldt Co	747,200	18,394	400	40	61,500	2,675	315,000	9,450	1,124,100	30,559
Del Norte Co	653,857	33,993	......	......	....	......	80,000	3,200	733,857	37,193
Total	8,024,035	392,335	90,871	6,513	9,735,726	543,458	5,462,692	149,092	23,313,324	1,091,398

Table of products of the fisheries of California in 1888—Continued.

Locality.	Mollusks.								
	Oysters.		Clams and mussels.		Abalone shells and meats.		Octopus and squid.		Total value
	Bushels.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	
San Diego Co	....	....	20,000	$936	940,000	$20,750	....	....	$21,686
Santa Barbara Co	....	....	....	....	53,825	2,291	....	....	2,291
San Luis Obispo Co	....	....	10,000	900	1,240	20	....	....	920
Monterey Co	....	....	....	....	10,855	515	230,000	$12,500	13,015
San Francisco Bay and vicinity	130,000	$509,175	2,294,415	75,248	2,600,000	55,000	14,000	1,120	640,543
Humboldt Co	....	....	72,000	1,200	....	....	....	....	1,200
Total	130,000	509,175	2,396,415	78,284	3,605,920	78,576	244,000	13,620	679,655

Locality.	Crustaceans.								Terrapins and frogs.	
	Crayfish.		Crabs.		Shrimp and prawn.		Total.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	No.	Value.
San Diego Co	36,400	$1,274	....	....	....	....	36,400	$1,274	....	....
Los Angeles Co	150,460	3,761	....	....	....	....	150,460	3,761	....	....
Santa Barbara Co	19,200	960	....	....	....	....	19,200	960	....	....
San Francisco Bay and vicinity	25,000	2,000	230,000	$37,200	4,902,360	$141,688	5,157,360	180,888	51,600	$12,900
Sacramento and San Joaquin Rivers	....	....	....	....	....	....	....	....	8,400	2,160
Total	231,060	7,995	230,000	$37,200	4,902,360	141,688	5,363.420	186,883	60,000	15,060

Locality.	Mammals.									Grand total value of fishery products.
	Skins of hair seal, fur seal,* sea lion, and walrus.		Pelts of sea otter.		Whalebone and ivory.		Whale and seal oil.		Total value.	
	No.	Value.	No.	Value.	Lbs.	Value.	Gals.	Value.		
San Diego Co	....	....	....	....	....	....	....	....	....	$63,069
Los Angeles Co	....	....	....	....	....	....	....	....	....	41,901
Santa Barbara Co	666	$1,050	25	$2,500	....	....	500	$110	$3,660	11,743
San Luis Obispo Co	....	....	....	....	....	....	6,750	2,340	2,340	7,743
Monterey Co	....	....	....	....	....	....	....	....	....	62,138
Santa Cruz Co	....	....	....	....	....	....	....	....	....	11,762
San Francisco Bay and vicinity	104,576	1,580,935	2,646	215,159	197,060	$585,895	284,959	102,384	2,484,373	3,854,257
Sacramento and San Joaquin Rivers.	....	....	....	....	....	....	....	....	....	341,804
Humboldt Co	....	....	....	....	....	....	....	....	....	31,759
Del Norte Co	....	....	....	....	....	....	....	....	....	37,193
Total	105,242	1,581,985	2,671	217,659	197,060	585,895	292,209	104,834	2,490,373	4,463,369

*The figures given under this caption include the number and value of fur-seal skins taken at the Pribilof Islands, in Bering Sea, which are a product of a fishery carried on by San Francisco capital. In 1888 the full limit of 100,000 skins was obtained at those islands, the value of which, as laid down at London, where they were sold, was estimated to be $1,550,000. In addition to the foregoing, the fur-seal industry of the Commander Islands (which belong to Russia) was controlled by American capital and the product was brought to San Francisco. In 1888 this amounted to 47,362 skins of fur seals, having a value of $544,663 at the average price paid in London. Combining these figures we have as the total yield of the fur-seal industry in 1888, 151,817 pelts, valued at $2,121,393.

Statistics of the salmon-canning industry of California in 1888.

Location of canneries.	No. of canneries.	No. of factory hands.	Salmon used for canning.		Canned salmon placed on market.	
			Pounds.	Price paid to fishermen.	Cases.	Value.
San Francisco	*2	33	453, 700	$22, 685	6, 875	$41, 250
Sacramento River	4	295	4, 039, 200	201, 960	61, 200	382, 500
Klamath River	1	12	288, 200	14, 410	4, 400	26, 400
Smith River	1	20	152, 555	6, 628	2, 347	14, 082
Total	8	360	4, 933, 655	245, 683	74, 822	464, 232

* These two canneries are not engaged exclusively in canning salmon, but are also devoted to fruit canning. In the item of factory hands the figures represent the proportional number of men who were employed in connection with the packing of salmon.

13. FISHERIES OF SAN DIEGO COUNTY.

Geographical characteristics.—This is the southernmost county of the United States on the Pacific coast. Its coast line has a moderate curve and extends in a northwesterly direction (nearly NNW.) from the Mexican boundary to Point Saint Mateo, a distance of about 57 geographical miles. Its shores are characterized by a fringe of beaches extending into the sea for some distance, while above them are generally steep, craggy headlands of sandstone, usually rising a little distance from the surf line. At varying distances from the shore, within 5 miles, is a ridge of stony bottom covered with kelp (*Macrocystis pyrifera*); in the bays where patches of kelp occur it is called "clam kelp" by the local fishermen.

Along this stretch of coast San Diego Bay is the only harbor suitable for important fishing operations, and the only landlocked harbor on the coast of California south of San Francisco, from which it is distant 450 miles in a SSE. direction, being only 12 miles north of the Mexican border. The claim is made that this is the best harbor on the Pacific coast; it is not so large, of course, as San Francisco Bay, but surpasses it in climate and security. It is 13 miles long, has a total area of 25 square miles, and an available anchorage ground of 6 square miles, while the average width of the channel is nearly one-half mile. It will therefore be seen that so far as harbor facilities are concerned San Diego has all the natural advantages requisite for the establishment and maintenance of important fisheries.

Immediately north of San Diego is False Bay, which is barred and so shallow at its entrance that it will not admit anything larger than a small boat; therefore it is not adapted to the purposes of an extensive fishery. North of False Bay the coast is practically unbroken, with the exception of one or two small streams that empty into the Pacific.

San Diego as a fishing center.—The fisheries of San Diego County center in the city of San Diego, situated on the bay of that name. Notwithstanding many important natural advantages, this place remained until recently an insignificant coast settlement, during all the years

since it was originally founded as a Franciscan mission in 1769. Its development has been quite remarkable since 1880, due to the establishment of railroad communication and the reputation which the city has attained as a health resort. In the last census year (1880) its population was only 2,637, but in recent years (1887–89) it has been estimated at 30,000 and upwards, though these estimates may have varied somewhat from the actual facts.

With the growth of the population and improvement in facilities for transportation it naturally followed there would be an increase in the local demand for fishery products and consequent improvement in the fisheries. The change in the fishing population since 1880 has been noticeable, not only in the increased number but also because Americans and Europeans constitute a much larger percentage than at that time, when the industry was controlled almost entirely by the Chinese.

The fisheries.—The fisheries of San Diego are of three distinct classes: The offshore vessel fishery, the junk fishery prosecuted by the Chinese, and the inshore fishery carried on in boats of less than 5 tons burden which are not documented. The development of the fisheries of San Diego has largely resulted from the increase of wealth and population in the city and surrounding country. The demand for fish has improved with the growth of the place, and the local supply has often not been adequate to meet it. With the continued advancement of the section, with improvements in vessels, methods, and facilities for shipment, new fishing grounds may be resorted to and larger quantities of fish taken and utilized.

Species, abundance, seasons, etc.—The species chiefly sought in this region are barracuda (*Sphyræna argentea*); bonito (*Sarda chilensis*), commonly known among the local fishermen as the "Spanish mackerel"; eel; flounders, commonly called "halibut"; mackerel (*Scomber colias*); herring (*Clupea mirabilis*); sardine (*Clupea sagax*); jewfish (*Stereolepis gigas*), locally known as the "sea bass"; mullet (*Mugil mexicanus*); rock-cod or "rockfish" (numerous species of *Sebastichthys*); sea bass (*Serranus clathratus*); smelt (*Atherinopsis californiensis* and *A. affinis*); and yellow-tail (*Seriola dorsalis*).

Of the two species of smelt, *A. californiensis* is locally known as the "bottom smelt" and is the most abundant and one of the most important of the food-fishes during the winter and spring. The other (*A. affinis*), called the "top smelt," occurs in San Diego Bay throughout the year. It is said to be abundant, but not so highly prized as the other.

There are several other varieties which are caught in smaller quantities or are less highly valued as food-fish. Among these may be mentioned the lady-fish (*Albula vulpes*); anchovies (*Stolephorus*), of which there are three species that are extensively caught and dried by the Chinese, one of which (*S. ringens*) will perhaps in time become an important species for canning; and the Spanish mackerel. The pompano is

occasionally taken in seines and is also caught from the wharves. The China croaker, common croaker, and the yellow-fin are all common and fairly abundant, both in San Diego and False Bays. Two species of so-called sea trout (*Cynoscion nobile* and *C. parvipinne*) are found in the bay in summer and are frequently brought into the market.

There are said to be eleven species of perches or surf-fish (*Embiotocidæ*) about San Diego. They are coarse, cheap fish, and comparatively unimportant, though very abundant and generally brought into the market every day.

Whitefish (*Caulolatilus princeps*) is a valuable species which is taken outside, but in comparatively small quantities.

The food-fishes of San Diego County are said to be much scarcer than in former years, and so far as certain species are concerned the decrease is attributed to the use of very small-meshed nets operated by the Chinese. A writer in the San Diego Union, of February 6, 1889, says:

Something should be done to put a stop to the wholesale destruction of fish by the Chinese, for on the schools thus destroyed depends the supply of edible fish. Fish enter the inlet chiefly for food, and when food is scarce few will come. * * * It is a sorry thing to see small fish by the bushels heaped together on the sands * * * and left to become food for the gulls. To empty them out into the water again does not save them, as their frail life is extinguished by being caught at all. No net of such fine mesh should be permitted.

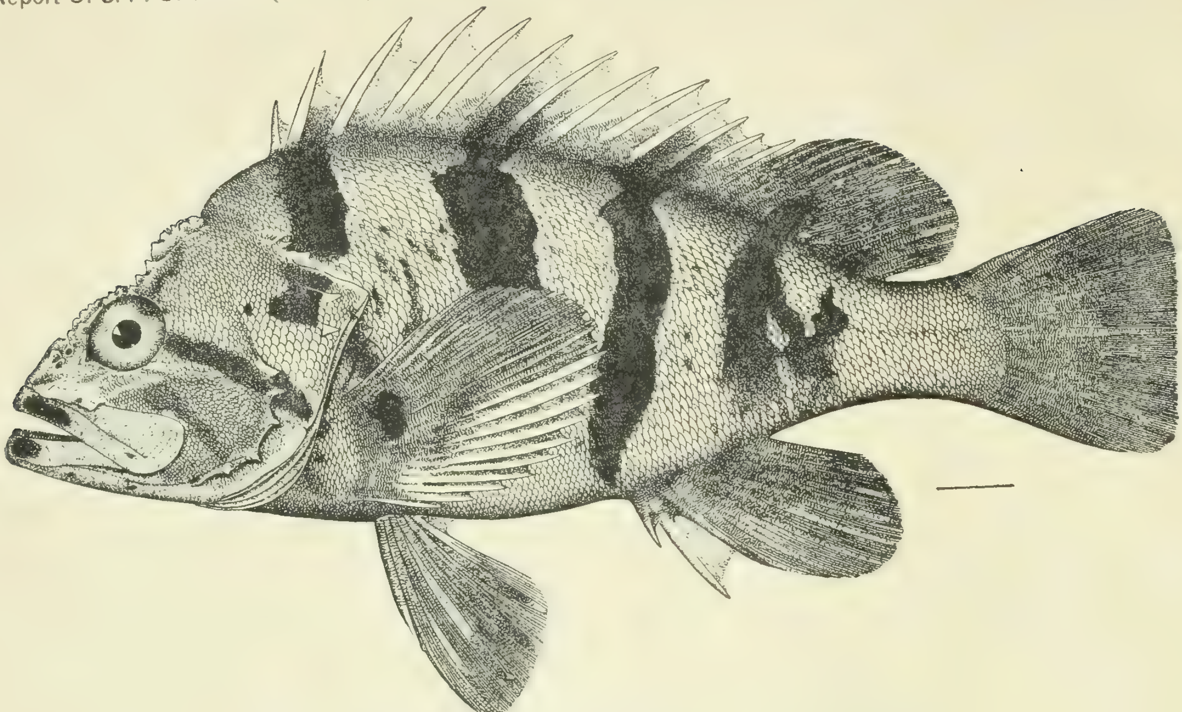
The bonito was very abundant in 1888, but the barracuda, which is also a migratory species, is said to be yearly decreasing. The former comes to the fishing grounds off this part of the coast in August and leaves in November or December, while the barracuda arrives in March or April and stays until late autumn, generally disappearing about a month earlier than the bonito.

The following notes on the barracuda and the fishery for it at San Diego were written by Prof. Carl H. Eigenmann, and have been extracted from *Zoe* for April, 1890:

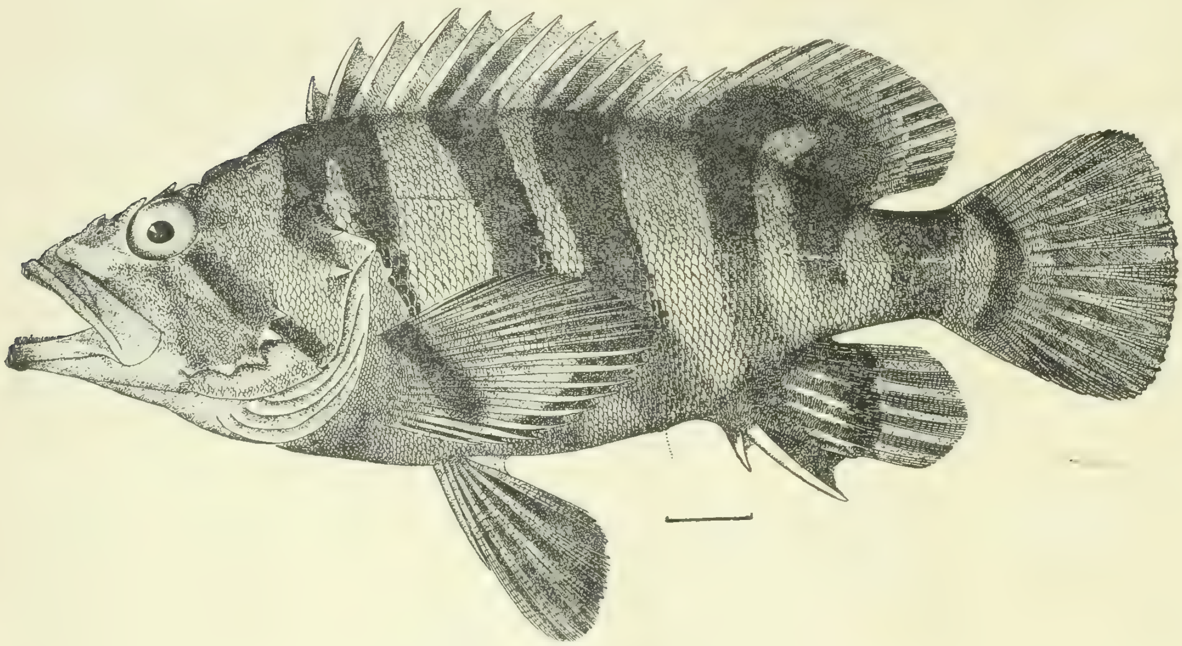
The barracuda (*Sphyræna argentea*) is one of the most important of California food-fishes. It is a long, slender, spindle-shaped, sharp-snouted fish, evidently well calculated to swim rapidly. In summer it is abundant on the whole coast of California from San Francisco southward, but it is probably more abundant southward than in the neighborhood of San Francisco. During the winter it disappears from the coast of California, but is taken on the coast of Lower California. It probably migrates bodily southward, but stray individuals undoubtedly remain in the waters of southern California throughout the year, for 2 or 3 days of exceptionally fine weather invariably bring them into the market. It is likely that these stray individuals live in deep water during the winter and come to the surface on bright days. It is quite possible, though not probable, that a great part of those disappearing descend to deeper water. The fact that they are taken only by the troll or by gill nets sufficiently explains why they should not be caught in deep water.

Their movements have been watched through an entire season at San Diego, and, as these observations may be valuable to serve as a basis of comparison, they may be stated here:

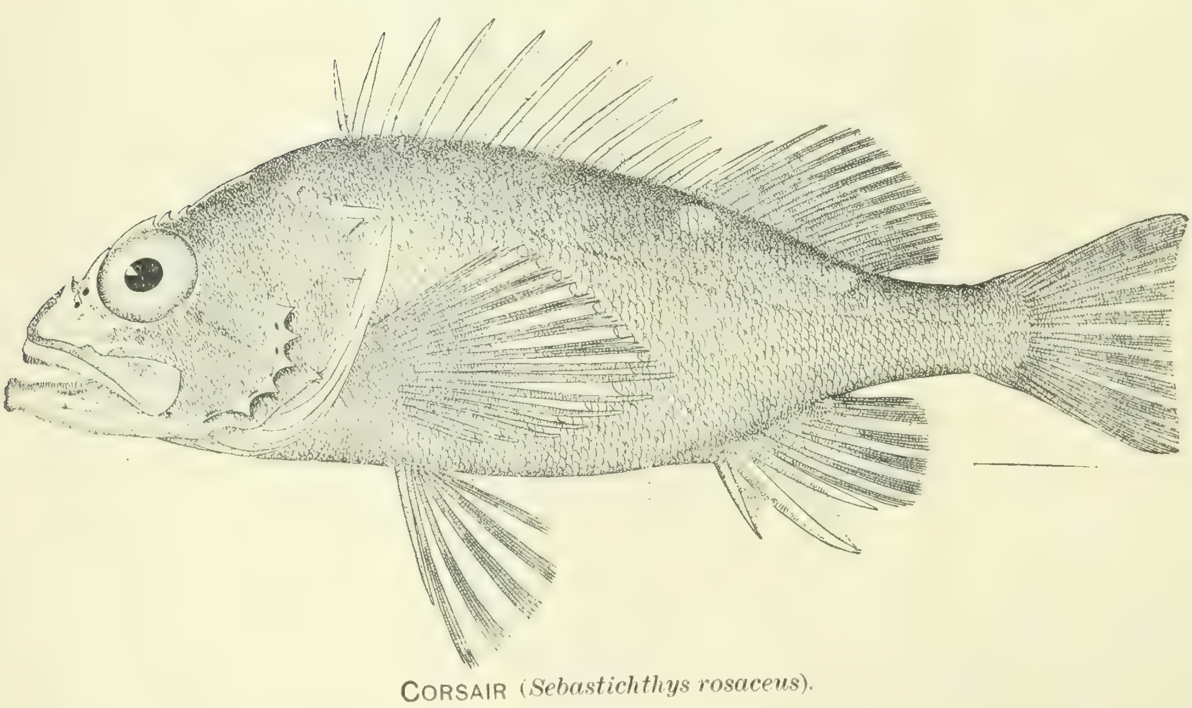
During January, 1890, none were seen. During February, 1890, four were taken on the 7th, one on the 11th, and two on the 28th. All these dates were at the end of a



BLACK-BANDED ROCKFISH (*Sebastichthys nigrocinctus*).



TREE-FISH (*Sebastichthys serriceps*).



CORSAIR (*Sebastichthys rosaceus*).

succession of days of exceptionally fine weather. On March 1, 1890, two were taken. On March 26, 1889, a few were caught, and on the following day they were abundant, and remained so, with occasional lapses, throughout the summer. At the beginning of July they were with ripe spawn.

During September few were taken, but on the 29th, 30th, and 31st of October they were again abundant. On November 6 one was taken, on the 7th another, on the 15th one young one was caught with a hook in the bay, and on the 18th another young one was brought from off Point Loma. On the 16th of December one young individual, evidently of the preceding summer's spawn, was taken in the bay, and on the 30th a large one was caught off Point Loma.

The adults never or very rarely enter the bay, but in the spring the young, those not yet a year old and measuring about a foot in length, enter the bay in large schools, and are then destroyed in quantities with seines or Chinese bag-nets.

About San Diego the troll is the only means used in catching them. It is simply a piece of white rag, or more commonly a fragment of bone, to which a hook is lashed. One or more of these is dragged behind a boat made usually after the pattern of the Columbia River salmon boat. The amount of the catch depends largely on the wind. A slack wind, even when barracuda are abundant, brings but few fish. The largest catch reported for a single day is 1,100 by one boat with two men. Rarely more than forty are taken. They average from 6 to 12 pounds and from 2½ to 4 feet in length, and retail at 10 cents apiece. Large numbers are salted and dried.

About Monterey they are taken in gill nets. In 1890 the first individuals reached Monterey on March 10.

Like most of the surface and shore food-fishes the barracuda feeds chiefly on the anchovy (*Stolephorus ringens*).

The mackerel comes in along this part of the coast in April. Large schools remain for a few weeks and then move north; they return in October or November, but in a few weeks go southward to the Mexican coast, where they are reported as being abundant during the winter months. A few are found off the coast of California throughout the year. Individuals weigh from 1 to 2½ pounds each and average about 1½ pounds. The Pacific mackerel never gets fat and does not improve with the advancing season like the Atlantic species. When salted, it is usually of a dark color and is an inferior article of food, though when fresh it sells readily in the market. Little attention is paid to the mackerel and the fishermen only catch enough to supply the local demand.

Twenty-seven species of *Sebastichthys* occur on the Pacific coast, of which at least twelve are taken by the fishermen of San Diego. The most common forms, omitting the yellow-tail (*S. flavidus*) are *S. miniatus*, *S. caurinus* subsp. *vexillaris*, and *S. ruber*, all of which are distinguished by their red color. There are also *S. mystinus* and *S. melanops*, which are black. Herring and sardines remain in San Diego Bay and its vicinity throughout the year, and large quantities are taken in drift and set gill-nets from March until November. The fishermen occasionally bring in small specimens of the so-called "black-cod" of the northern Pacific (*Anoplopoma fimbria*), which apparently nearly reaches its southern limit of distribution off this part of the coast. Neither sturgeon nor salmon are found in these waters.

Porpoises are plenty in the bay and along the coast and whales are

often numerous in the spring and fall, though no attempt is made to capture either. Sea otter and fur seal, once abundant, seem to have been almost exterminated or to have abandoned this locality. This will be apparent when it is stated that, while the result of the fur-seal fishery in 1879 was 2,000 skins, in 1888 only 25 skins were taken. Hair seals are quite numerous, but receive little attention.

Other objects of the fisheries are abalones (*Haliotis splendens*), clams, and crayfish or rock lobster (*Panulirus interruptus*). The supply of abalone shells has decreased very materially. Clams of a large size, resembling the deep-sea clam of the Atlantic, are abundant on the flats in the bay and are used to a small extent both for food and bait. Scallops are abundant at times and a few are picked up on the flats at low tide, but there is no fishery for them. Edible crabs are very scarce; the small fiddler crab is the only representative of this tribe which occurs abundantly.

Fishermen.—The fishing population of San Diego is very heterogeneous in its character. In 1888, out of a total of 159 fishermen, only 46 were Americans;* the remainder included 52 Chinamen, 27 Portuguese, 6 Italians, 5 Swedes, and 13 of other nationalities. The Chinese have exclusive control of the junk fishery and frequently engage to a greater or less extent in the fisheries of the bay. The Americans and Europeans control the vessel and sailboat fisheries.

THE OFFSHORE FISHERY.

Fishing grounds.—The fishing grounds for bonito and barracuda can not be definitely described. In general, however, they extend along the coast from north of San Diego to a long distance southward, off Mexico. Sometimes, when fish are not found in abundance near the home port, the vessels go from 200 to 300 miles to the southward for fares. In spring a favorite fishing ground for bonito and barracuda is from 6 to 8 miles about SSE. from Coronada Hotel, which is a little over 3 miles eastward of Point Loma. Fishing is also prosecuted from 6 to 8 miles outside of the kelp beds, from Point Loma to False Bay, and gill nets as well as trolls are used in that region to a small extent, more particularly by boat fishermen.

In the winter of 1888–89 the U. S. Fish Commission steamer *Albatross* discovered and made a thorough exploration of Tanner Bank, which lies directly westward of San Diego, about 95 miles distant. This bank is 7 or 8 miles long, and about 2 miles wide. The *Albatross* also made a comprehensive investigation of Cortez Bank, which lies about 12 miles south of Tanner Bank, and has a length of 14 miles and a width of from 3 to 5 miles. These were found to be important fishing grounds,

* Professor Jordan, reporting on the fisheries of San Diego in 1879, says: "All of the fishermen of this county, excepting four Americans and their employés, are Chinamen. Two Americans and assistants are employed in seal-hunting, the rest in gathering kelp, and, in their seasons, bonito and barracuda fishing."

and the establishment of the fact that valuable food species were taken there was a matter of much gratification to the fishermen of San Diego, who anticipated, in consequence, an increase in their operations.

Lieut. Commander Z. L. Tanner, U. S. Navy, who commanded the *Albatross*, reported that he found numerous species of food-fish in great abundance on Cortez Bank, all of which took the hook readily. Among these were fat-heads, whitefish, yellow-tail, rock-cod, four species of red rock-cod, jewfish, cultus-cod, and sea bass.

When informed officially of this abundance of fish "the citizens of San Diego raised a fund for the purpose of chartering and equipping a fishing schooner for making exploring expeditions so as to determine their extent. A number of trips were made in the summer of 1889, and many thousand pounds of fish were taken, fully substantiating the Government report as to the abundance and quality of the fish. * * * No fishermen have as yet gone to the Cortez Bank, though occasionally some of them go as far coastwise to the south. The fact that no fishermen have been at the Cortez Banks is perhaps the reason why so much interest is taken by them in the explorations of the *Albatross*. As an addition to the fishing grounds skirting the coast these banks are of value to San Diego fishermen."*

Vessels.—The vessels employed in the sea fisheries from San Diego, exclusive of the Chinese junks, which will be described elsewhere, are small, ranging from less than 7 tons to between 24 and 25 tons register. In 1888 they numbered 7 schooners and 2 sloops, and had a total tonnage of 136.15 tons. The number varies considerably from year to year. In 1880 and 1881 there were 6 vessels, aggregating 78.61 tons, but in 1882 the number decreased to 3 vessels of 33.03 tons; and to 1 vessel of 9.38 tons in the year 1883. The fleet increased to 5 vessels, of 45.80 tons, in 1884; 7 vessels, of 79.16 tons, in 1885, while the next year saw only 3 vessels, of 28.2 tons, engaged in the fisheries, though in 1887 they again increased to 5 vessels, of 52.90 tons. It will readily be seen that vessels of this description are not suitable for carrying on an extensive fishery, and the fact that they are all tight-bottomed craft renders them poorly fitted for taking to market any fish other than those which are salted, unless caught near the harbor under circumstances specially favorable for reaching port. Elsewhere reference will be made to suggestions advanced by the writer for improvements in fishing craft used from San Diego.

---

* San Diego Sun, October 31, 1889. Since the above-quoted statements appeared in the San Diego Sun, and not long after the investigation of the banks by the *Albatross*, a fishing company was formed at San Diego for the purpose of prosecuting voyages to these grounds. Several trips were made, but, according to the best information obtainable, the enterprise was not a financial success. Its failure was largely due to the fact that (notwithstanding the report to the contrary made by the *Albatross*) the enterprise was started on the false assumption that the true cod (*Gadus morrhua*) could be taken in abundance. Other species were plentiful, but the lack of demand made their capture unprofitable.

Apparatus of capture.—The apparatus used for the capture of bonito and barracuda (the principal species sought for by the vessels) consists of a troll line of soft-laid cotton twine about 60 feet long, with a drail from 3 to 4 inches long of bone or iron, and a hook fastened to it. The hook has its barb filed off blunt, so that it will not be difficult to extract it from the fish, and it is fastened to the lower end of the drail with a rivet through the eye and a piece of wire passing around its shank through two holes in the drail. When the fishermen can not get drails they sometimes use an ordinary hook with a piece of rag tied around the shank as a substitute. The bone drail is said to be preferred for barracuda fishing.

Methods of fishing.—When engaged in trolling for barracuda or bonito a vessel moves along under easy sail, and six or eight lines are kept out at one time; no bait is used, as the fish will readily bite at the drails employed for their capture. The method is similar to that adopted on the Atlantic coast for catching bluefish.

The following account of fishing for barracuda at San Diego is from an article written by J. C. Van Hook and published in Forest and Stream of October 31, 1889:

At daybreak we were drifting past Ballast Point, the entrance to the bay. After floating a mile out into the ocean, assisted occasionally by a "cat's-paw," we concluded to tie up to the kelp and wait for the wind. Here we enjoyed for an hour the continuous up-and-down motion of the heavy ground swell, sometimes throwing out a line as far as possible and pulling it in rapidly to entice the barracuda which were playing around us, but without success. So we * * * waited patiently for the breeze, which is indispensable for barracuda fishing as it is in the Atlantic for that wily corsair, the bluefish. * * * I heard something like the surf breaking on the shore * * * and about 1,500 porpoises were coming toward us in a line, jumping out of the water and looking like big black wheels rolling along. * * * About 9 o'clock a light breeze sprung up, and, cutting loose from the kelp, we began to move slowly over the water, but not fast enough, as Bob said, to put out our lines. In my anxiety to begin the sport I cast out two lines, and very soon we hooked two so-called Spanish mackerel [bonito] of 10 and 12 pounds apiece. * * * Presently the breeze came along, and within half an hour we were sailing at a lively rate, so we adjusted outriggers, one on either side, about in the waist of the boat, with two lines on each. We also trolled one from the stern, making five in all. Just then we met our friends coming home, loaded with sixty-five barracuda, which they had caught by towing and trolling while we were tied up to the kelp. Being thus encouraged, we put everything in readiness and placed in front of the cabin door a fish box 3 by 3 by 3 feet. Bob had the first strike and pulled in his fish, then he hooked and landed another, and a third. As I was beginning to wonder what was the matter with my lines one of them straightened out, and I began to haul in hand over hand. When I was about to lift him out of the water he doubled himself up, and I brought out the bare hook. I repeated this three times. * * * Upon hooking another I pulled in slowly, and when the fish was 3 feet from the boat I threw him up into the air, bringing him over my head and landed him into the box. Then by catching hold of the drail and shaking it the fish came off easily. As I found out, all the drails for barracuda fishing have the barb of the hook filed very blunt, and an inexperienced person might easily lose his fish, while, at the same time, the hook is readily jerked out of the mouth free from the lance-like teeth.

Now the fun commenced in earnest; first one, then two, four, five, are hooked at a time, and rare sport it was to haul them in. For about 5 minutes we had all we could handle, and then for 10 or 15 minutes we would not see a sign of one. Now we are into them again, hauling away for dear life. Sometimes when hauling in one or two they would become entangled with the other lines, and before we could get them in we would have one, two, or three on the remaining lines, and then there was a sad jumble of lines and struggling fish. Occasionally, in attempting to land the fish in the box, we missed it, and they fell down into the bottom of the boat, or our footing would be lost and we were bunched in a slippery mass—fish and all. The sloop was pitching heavily, as half a gale of wind was blowing. Wet from the waist down, we had what you might call a huge time. The drails towed at the surface of the water and we could see nearly every fish that took hold. We caught 68 barracuda and 2 Spanish mackerel—about 425 pounds of fish—filling our box; and with the loss of only one hook. Having all the fish we wanted by 2 p. m., although the biting was as furious as ever, we got under way to save the wind home. The fish were selling at the time for 10 cents each. The favorite haunts of the barracuda are in and along the edge of the kelp. Sometimes they can be seen in a mass, making the water boil with their frantic leaping; there may be 50 out of the water at a time and as many more just disappearing under the surface.

Preparation and disposition of products.—On board the small vessels fish are usually dressed soon after they are caught, and thoroughly salted in kench; on the vessel's return to port the fish are washed and spread on drying flakes, where the barracuda are left for from 2 to 4 days and the bonito from 4 days to a week. So prepared, the fish are dark in color, oily, and have a strong flavor. They are marketed only in San Francisco, whence most of them are exported to China. In addition to the fish taken, these vessels incidentally collect large quantities of abalone shells along the Mexican shores, which form quite an important item in their returns.

Results of the fishery, lay, etc.—The total products of the San Diego vessel fishery in 1888, exclusive of the junk fishery hereafter to be considered, was 225,393 pounds of salt fish, 53,656 pounds of abalone shells, and 35,229 pounds of abalone meats. The owner of the vessel receives one-fifth of her gross stock, or of the catch, and the remainder is divided among the crew, who furnish all the outfit except small boats.

CHINESE JUNK FISHERY.

Fishing grounds.—The Chinese engaged in the junk fishery work chiefly among the islands and along the coast of Mexico, where they gather abalones from the rocks. Abalones were formerly abundant in the vicinity of San Diego Bay, but the local supply has been exhausted. The fishing grounds principally resorted to by the Chinese, therefore, may be said to be off the Mexican coast. The junks, however, often engage in the capture of small fish in the shallow littoral waters near San Diego. The favorite grounds of the Chinese are south of the city near the peninsula called "the island," and also off the mouth of the Sweetwater and La Doronde Rivers. Bartolome Bay, Lower California, is a favorite resort for the junk fishermen.

Chinese boats.—The junks used by the Chinese fishermen of San Diego are mostly built at San Francisco. Since 1880 their number has been 13, aggregating 141.01 tons, with a value of $5,200, and manned by 52 Chinese fishermen. The junks vary from 7 to 15 tons. They carry no papers except an alien certificate, which insures to the crew permission to land upon their return to the city. In addition to their Chinese names, the junks are numbered by the customs officers, and are known to them by their numbers only.

The junks return as seldom as possible, but if they have occasion to visit San Diego, with or without cargo, they report at once to the custom-house and pay a tonnage tax of 83 cents per ton; $1.50 for entering, 67 cents for survey, and 20 cents for a certificate. It is currently reported that, to avoid payment of these customs dues, the junks often transfer their cargoes of abalone shells, meats, etc., to small boats that come out to sea, off San Diego, for this purpose, and to bring supplies.

Apparatus.—The Chinese use large drag nets or seines, called "bag nets" by the American fishermen, because in the bunt, or center, is a large bag-shaped pocket into which the fish find their way. These bag nets vary from 250 to 300 fathoms in length, and the bag or pocket is about 40 feet deep, with a wing extending on each side to a distance of from about 120 to 140 fathoms, and having a depth of 2 fathoms. The wings are 2-inch mesh and the bag ½-inch mesh. Each junk carries one or more small flat-bottom boats, somewhat resembling the sharpie in form, for the purpose of collecting abalone shells and for other fishing operations.

Methods of fishing, preparation of products, etc.—The catch of the Chinese junks consists chiefly of abalones gathered from the rocky shores along the Mexican coast. The meats are taken from the shells and boiled on shore in rude vats made of sheet iron, and stone or bricks. Both the shells and meats are then packed in sacks containing from 100 to 125 pounds each. On the arrival of a junk her cargo is sold to the dealers, by whom the shells are culled and repacked. The products are then forwarded to San Francisco, whence most of the meats are exported to China and the shells shipped to France.

In the bag-net or drag-seine fishery prosecuted by the Chinese in San Diego Bay and vicinity, the net is run out in shallow water at some distance from the land in localities known to be favorite resorts for certain species of fish. From each wing of the net a line extends to the shore, and it is gradually drawn in by the fishermen until the ends reach the land. The fish inclosed naturally find their way into the bag in the bunt, which is at last drawn on shore with its contents. The mesh of this bag is so small that there is no chance for escape of the smallest fish, and many are taken only an inch or two in length. Sometimes the Chinese fishermen, during the months of March, April, and May, stretch their nets at high tide entirely across a small stream, and at low tide draw them in again filled with smelt, mullet, and other small fish.

These destructive methods of fishing have been the cause of much complaint. State Deputy Fish Commissioner William Kehoe tried to stop this net fishing, and seized the nets of the Chinese, but as late as May, 1889, the legality of the fishery had not been decided, as the matter was then before the courts.

The fish taken by the Chinese are generally salted and dried, and find their way to San Francisco, whence most of them are exported to China.

Products.—The catch of the Chinese junks in 1888 amounted to 75,000 pounds of salted fish, 646,344 pounds of abalone shells, and 204,771 pounds of abalone meats.

BOAT FISHERY.

Fishing grounds.—The fishing grounds most commonly resorted to by the boat fishermen of San Diego are those frequented for gill-net fishing in the bay from Point Loma to some distance southeast of the city and northwardly from Point Loma, both inside and outside the kelp beds; also in False Bay, where nets are used for smelt, herring, and flounders. Gill-net fishing is carried on at all seasons on the grounds stretching for 10 miles northward from Point Loma. During March, April, and May bonito and barracuda are taken by boat fishermen with troll lines and occasionally with gill nets south and west of Point Loma. Traps or pots are set for crayfish or "rock-lobsters" along the main shore inside of the kelp bed, from Point Loma northward. The favorite ground for the collection of large sea clams for bait and food is on the shallow spit called "Zuninga Shoal," extending southwardly for more than a mile from the south side of the channel, opposite Ballast Point, at the entrance of the bay.

Boats.—Many sailboats at San Diego, and particularly those used by the Italians and Portuguese, are the same type as the feluccas sailing from San Francisco. They are tight-bottomed craft, and, as no ice is used on account of its expense at San Diego, the catch of the boat fishermen is often in a bad condition when it reaches port. For this reason the writer has prepared and published plans of a welled boat, in which fish can be kept alive; such a boat might be very advantageously used in the market fishery of San Diego.

Apparatus of capture.—The apparatus of capture used by the boat fishermen consists of gill nets, hand lines, or troll lines, and pots and traps for catching crayfish; the latter are set along the shore with buoys attached to them by lines to mark their positions.

Method of fishing.—The description given of catching bonito, barracuda, and mackerel under the head of vessel fishery will apply to the boat fishery, so far as troll-line fishing is concerned. Two methods are adopted in using gill nets. When nets are set in bays and along the shores they are anchored; but in the open water, 6 or 8 miles outside the kelp fields, they are "set at a drift," the method adopted in the latter case being precisely similar to that used in the so-called "drag

net fishery" of New England. The catch around the kelp consists chiefly of bonito, barracuda, rock-cod, and smelt; but in the bays the species principally taken are herring, smelt, and flounders.

The boats as a rule leave San Diego in the early morning, at which time there is generally a land breeze blowing off the coast, that enables them to run to the fishing grounds. In the afternoon a sea breeze usually springs up and with this they return to port with their day's catch, unless the fishermen decide to remain longer on the fishing grounds and return on the second day. Frequently, however, they fail to get the breeze necessary to carry them to the city, and their catch is in a deteriorated condition, and perhaps unfit for food, before they can reach port and dispose of it. Ice is too costly to be used by fishermen, who are therefore often deprived entirely of the results of their labors.

The following tabulated statements show in detail the fisheries of the county in 1888:

Persons employed.

Country.	Nativity.	Nationality.
United States	46	46
Italy	12	12
Portugal	37	37
Sweden	12	12
China	52	52
Total	159	159

Apparatus and capital.

Designation.	No.	Value.
Vessels* (277.16 tons)	22	$13, 200
Outfit	......	7, 300
Boats	43	8, 910
Gill nets	17	1, 125
Drag seines	8	1, 000
Hand lines and trawl lines, with 5,400 hooks	......	200
Crayfish traps	60	90
Shore property	......	1, 000
Total	......	32, 825

* Including 13 Chinese junks (141.01 tons), valued at $5,200.

Products and values.

Species.	Fresh.		Salted.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Fish:						
Barracuda	315, 200	$9, 456	213, 500	$8, 540. 00	528, 700	$17, 996. 00
Bonito	164, 500	4, 935	254, 409	10, 176. 36	418, 909	15, 111. 36
Jewfish	10, 000	300	7, 314	292. 56	17, 314	592. 56
Rockfish	75, 000	2, 250	22, 655	906. 20	97, 655	3, 156. 20
Yellow-tail	50, 000	1, 500	32, 342	1, 293. 68	82, 342	2, 793. 68
Miscellaneous species *	15, 300	459	....	....	15, 300	459. 00
Shellfish, crustaceans, etc.:						
Abalone shells	700, 000	8, 750	....	....	700, 000	8, 750. 00
Abalone meats	240, 000	12, 000	....	....	240, 000	12, 000. 00
Clams	20, 000	936	....	....	20, 000	936. 00
Crayfish	36, 400	1, 274	....	....	36, 400	1, 274. 00
Total	1, 626, 400	41, 860	530, 220	21, 208. 80	2, 156, 620	63, 068. 80

* Includes sea bass, smelt, herring, and flounders.

14. FISHERIES OF LOS ANGELES COUNTY.

Geographical characteristics.—Los Angeles County adjoins San Diego County on the northwest, and its coast line has an extent of about 120 miles, the general trend being in a northwesterly direction. Except in the northern section, the shores are generally low with a greater number of small lagoons and sandy stretches of coast than in San Diego County, while bold headlands are less numerous and conspicuous.

The principal indentations are San Pedro and Santa Monica Bays, situated on either side of the broad peninsula upon the extremity of which is located the town of San Pedro. Santa Monica Bay is on the north and San Pedro Bay on the south of the peninsula, and both are open roadsteads, unsheltered from southerly or westerly winds. Wilmington, on San Pedro Bay, 3 miles from San Pedro, on the line of the Southern Pacific Railroad, has the only harbor of any importance on the shores of this county, and this is only a narrow, shallow inlet, somewhat difficult of access to large vessels. The breakwater at San Pedro, which is a railroad terminus, makes a good harbor for fishing boats.

Santa Catalina Island is 18 miles distant from the mainland, and its center bears a little to the west of south from the city of San Pedro. It is about 22 miles long, its length being parallel to the coast, and varies in general width from 3 to 8 miles. The island is mountainous, while the shores are rocky, high, and abrupt. There are no indentations sufficiently large and protected to afford harbor facilities even for fishing boats, except at a point a short distance northwesterly from the center, where the island is very nearly divided, and a harbor is thus formed on each side of the narrow isthmus that connects the two sections. The harbor on the southwestern side is considered the better, it being well sheltered and having a good depth of water. All around the island the water is remarkably clear, so that fish can be seen at a depth of several fathoms.

Fishing centers.—The localities from which fishing is prosecuted are Portuguese Bend, White Point, San Pedro, Wilmington, Santa Monica, and Santa Catalina Island. The latter has no permanent residents except shepherds and a few fishermen.

Portuguese Bend was a shore whaling station of some importance for a number of years, but no whales have been taken there since 1884. It had become an abandoned station as early as 1875, for Jordan records in 1880 that "a whale fishery formerly existed at Portuguese Bend, north of Wilmington; this fishery was abandoned some 5 years ago on account of the difficulty of obtaining water at that place."

The fisheries are largely tributary to the towns of San Pedro and Wilmington, which being situated on a railroad that strikes the coast are the shipping-points for an extensive area in the interior.

Importance of the fisheries.—The seacoast fisheries of this county are, next to those of San Francisco and San Diego, the most important in

the State. Compared with 1880, the fishing industry shows a great increase. It is still capable of considerable development, as a result of the increased demand for fish in the growing and already populous regions of the interior reached by the railroad. Much may also be hoped for from the introduction of new and improved methods in handling and shipping fish. Many varieties of excellent food-fish abound. The weather is favorable to fishing a large part of the year, while the fishing grounds are conveniently near the points from which the products must be shipped, the most remote being about Catalina Island, only 18 or 20 miles distant.

Species that are objects of fisheries.—The waters bordering and adjacent to the county of Los Angeles supply a large list of edible fishes, crustaceans, mollusks, etc., among which may be found some of the most desirable species of the Pacific. This will more clearly appear by an examination of the following list and notes, which refer to the more noticeable forms. The first four species mentioned in the list, together with the crayfish or rock-lobster, have the greatest commercial importance at the present time:

Barracuda.
Whitefish (*Caulolatilus princeps*).
Roncador.
Smelt.
Rock bass.
Sea bass.
Jewfish.
Bastard halibut (*Paralichthys californicus*).
Flounders.
Whiting (*Microgadus proximus*).
Sardine.
Yellow-tail.
Mackerel.
Bonito.
Horse mackerel (*Trachurus picturatus*).
Pompano (*S. simillimus*).
Fat-head or redfish (*Trochocopus pulcher*).
Croaker.
Oil shark.
Rockfish (*Sebastichthys*).
Flyingfish (*Exocœtus californicus*).
Perch.
Kingfish (*S. politus*).
Mullet.

Barracuda, bonito, yellow-tail, and several other varieties are taken by trolling in summer, as well as by gill nets, while in winter other species are chiefly sought, among which Jordan mentions *Media luna*, *Girella nigricans*, rockfish, *Scorpæna guttata*, and *Hypsypops rubicundus*.

Jewfish, though not numerous, attain a large size, ranging from 300 to 400 pounds, while individuals weighing much more are sometimes taken. They are sold fresh, but are also cut into strips, salted, and then dried. The dried product is somewhat tough and of a whitish color, resembling the flesh of the dried cusk (*Brosmius brosme*) as cured in New England.

The mackerel are identical with the bull's-eye or thimble-eye mackerel of the Atlantic. Wilcox states, however, that they are little esteemed even by the coast residents. Alexander says that all the people with whom he had conversed said they had never seen a fat mackerel caught in the Pacific.

Clams and scallops are abundant, but have no market value at present. Campers and ranchmen occasionally visit the beds and obtain supplies for immediate use, but outside of this the consumption is very

small. It is reasonable to anticipate marked changes in the demand for these mollusks in the near future.

Several beds of native oysters occur between San Pedro and Wilmington, in San Pedro Bay and other localities, notably at Newport Bay. The oysters attain a fair size for indigenous species, and, according to Wilcox, do not have the strong coppery flavor characteristic of native Pacific oysters in many other places. They are eaten to a limited extent by the old settlers, who are said to have no objection to the peculiar flavor which is almost an insurmountable obstacle to the use of the species by newcomers. A few oysters are utilized, but the demand for them is so small that they are commercially unimportant. In Newport Bay the fishermen occasionally cull the oysters and peddle the selected ones through the country, but this business is of slight importance and scarcely deserves mention. Native oysters are found in Alemidos Bay, but they are too small to be in any demand for food purposes at the present time.

In 1888 one shad weighing 2½ pounds was taken in San Pedro Bay. This is the only known occurrence of the shad so far south on the Pacific coast.

The oil shark was formerly the object of a considerable fishery, being taken in the lagoons where it went for reproductive purposes. It attains an average length of 4 to 4½ feet and a weight of 40 to 50 pounds, and yields from two-thirds of a gallon to a gallon of oil. The fins of this shark were formerly considered quite a delicacy; they were dried and sold for 12½ cents per pound. This fishery appears to be entirely abandoned as a commercial enterprise, for Wilcox could learn nothing of its prosecution in recent years.

Fishing grounds.—The fishing grounds resorted to by the residents of this county may be classed under three headings: Those about Santa Catalina Island, the "banks" lying between the island and the mainland, and the shore grounds (including clam and oyster beds, etc.) situated along the coast or in the lagoons, bays, etc.

The immediate vicinity of Santa Catalina Island is one of the most important fishing grounds of this county. The bottom is generally rocky and in many places covered with kelp; but the water is very clear, while it is rather shallow about the island. For the most part fishing for bottom species is prosecuted in depths ranging from 10 to 20 feet, where it is practicable to watch every movement of the fish, if the surface of the sea is unruffled by a breeze. The most important species are barracuda, bonito, rockfish, and jewfish. Large schools of herring are frequently seen about this island. Seals and sea lions frequent Santa Catalina Island and the adjacent waters; one may be occasionally shot, but beyond being an annoyance to the fishermen, whose nets they rob, they may very properly be omitted from mention.

The so-called offshore bank lies between Santa Catalina Island and the mainland, being much nearer the latter. Its northern limit is

about 6 miles southeast from San Pedro Landing, whence it extends southeasterly, nearly parallel with the coast, a distance of about 20 miles. It is a favorite resort for hand-line fishermen at certain seasons.

San Pedro Bay is much frequented by fishermen using troll lines; gill nets are set in the shallow water along its northeastern shore.

Fishermen.—In 1888 the fisheries of Los Angeles County employed 137 men, of whom all except 3 were foreign-born, though 75 were citizens of the United States. The natives of southern Europe predominate, Portugal, Italy, and Greece being represented, while next in number are the Scandinavians. The American-born fishermen are natives of New England. The Chinese have no foothold, and there is only a single native of the British provinces.

Boats.—The fishing boats are all under 5 tons, and mostly small, undecked craft. The majority are lateen-rigged feluccas or catboats; but there are a few sloops and schooners, with sprit-rigged sails. Some flat-bottomed boats of the sharpie or bateau type are used. The sailboats are worth from $75 to $400 each, and the few small rowboats used from $20 to $25 each. The largest sailboats are similar to the feluccas used at San Francisco, and are deemed very seaworthy. A boat is seldom lost here. In 1888 a San Pedro boat was wrecked and her crew of two men drowned, this being the only loss of life there for many years.

Apparatus of capture.—It will be practicable here to refer only to the most important forms of apparatus.

A total of 73 gill nets were used in the fisheries of this county in 1888, and they were employed at all the stations except at Portuguese Bend. A considerable number of species are taken in gill nets, among which the barracuda is one of the most important. The nets are mostly about 40 fathoms long, and range in value from $25 to $30. The barracuda nets are 40 fathoms long and 12 feet deep, made of 9-thread twine, and having a 4-inch mesh. Two or more of these nets are often tied together, end to end, and set in a string.

Nine haul or drag seines, each 600 feet long and valued at $140, were operated from San Pedro and Wilmington.

From all the fishing stations except Portuguese Bend hand lines (including troll lines) and trawls were used to some extent; these have been described elsewhere. There were 41,500 hooks on the trawls, worth, with the lines, etc., $680.

Three bag nets or paranzellas were fished at San Pedro and Wilmington, chiefly in the bay on sandy bottom.

Crayfish pots are used by the fishermen of San Pedro, Wilmington, Portuguese Bend, and White Point. They are operated quite extensively about Santa Catalina Island. They are set along the coast close inshore like lobster pots.

Methods of fishing.—The fishermen start for the fishing grounds on the so-called offshore bank and around Santa Catalina Island, early in

the day, timing their departure so that the "land breeze," which usually prevails in the morning, will enable them to reach the desired locality as soon as fishing can be profitably prosecuted. They plan to return about 5 p. m., coming home with the "sea breeze" when practicable.

The fishing crews generally consist of four men on each of the larger boats, particularly those belonging at Wilmington which fish about Santa Catalina Island. These boats do not always return to port the same day they leave home. They also often leave half of their crews at the island to fish in small boats, while the larger craft return to the home ports with their cargoes of fish. The men who stay behind at the island set and haul their gill nets or crayfish pots, or perhaps operate hand lines and trawl lines near the shore. So plentiful are the fish that it often happens that another fare is caught by the time the larger boat returns. Boats that fish upon the bank and those working along the shore near the mainland generally return home every night.

The boats using gill nets may go out late in the day and, having set their gear over night, haul it in the morning and make for harbor, unless they use other gear during the day. All other fishing, however, is usually prosecuted in the early part of the day.

Ice is not used, because it is either not to be had or is scarce and costly.* Boats are frequently becalmed on the fishing grounds or on their return to market, and the entire catch spoils and is thrown away. The loss from this cause is considerable.

Even when the fish are landed in good condition it is seldom that the proper methods for their preservation, packing, and shipment are observed. The round fish are usually left in the boat until the next morning after their arrival, when they are shipped by rail or team in small boxes without ice. The products kept so long in warm weather without refrigeration of any kind must be in a more or less advanced stage of deterioration before they reach the consumer, and at times the railroad authorities have refused to transport fish, knowing they were not in a marketable condition.

In view of these facts it is apparent that welled boats, in which fish can be kept alive, or small steamers that can quickly transport the catch from Santa Catalina, are much needed here, as on other parts of the Pacific coast, to contribute to the full development of the fisheries. By the use of welled boats it will be practicable to remain longer on the distant fishing grounds and, what is of still greater importance, the catch can be landed in the best possible condition, alive. Any surplus could be kept alive in floating live-cars (wherever these can be safely anchored) until demand is made for their shipment.

Prior to adopting this system of bringing in live fish much can be done by giving more attention to the preservation of the catch. If the viscera are removed on the fishing grounds and even a little ice used,

* The price of ice at San Pedro in 1888 was $10 per ton.

the fish being packed in a closely covered section of the boat, the catch would generally reach port in good condition. Then with a little more ice it could reach a much wider area of distribution than is now possible, while the increase in demand would doubtless more than repay the fisherman for any additional outlay or effort.

It is believed that the fishing interests of this section will be materially advanced when these suggestions are acted upon. The public are not slow to appreciate whatever tends to improve the food supply, and the introduction of advanced ideas in the fresh-fish trade will correspondingly increase the demand for this class of food.

Markets and shipments.—Although Santa Monica, Alemidos Bay, and Newport Landing have local markets and direct trade with the interior, the principal part of the fish taken in this county is first sent to San Pedro and Wilmington, whence the products are shipped to Los Angeles, 25 miles distant, Pasadena, Riverside, Long Beach, and other communities on the line of the railroads. There is also some local demand at San Pedro and Wilmington. Los Angeles, with about 70,000 inhabitants, is the principal market and distributing center for the fishery products of the county. It has five firms engaged in handling fish. About two-thirds of the products landed at San Pedro and Wilmington are shipped by express to Los Angeles, while about one-third is taken in teams from Wilmington, which peddle the fish en route to the same city and dispose of a considerable quantity therein. The fish salted and dried on Santa Catalina Island are cured for the San Francisco market, to which they are sent from San Pedro. The fresh-fish trade, as has been indicated, is comparatively local.

The following tables show in detail the statistics of the fisheries of this county:

Persons employed.

Fishing center.	Nativity.							Nationality.						
	United States.	British provinces.	Portugal.	Italy.	Sweden.	Greece.	Total.	United States.	British provinces.	Portugal.	Italy.	Sweden.	Greece.	Total.
San Pedro and Wilmington	3	1	22	15	32	6	79	40	....	10	8	15	6	79
Santa Monica	....	....	8	....	....	....	8	5	....	3	....	....	....	8
Alemidos Bay	....	....	8	....	....	....	8	4	....	4	....	....	....	8
Newport Landing	....	....	20	....	....	....	20	10	....	10	....	....	....	20
Santa Catalina Island	....	....	12	....	....	....	12	6	....	6	....	....	....	12
Portuguese Bend	....	....	....	....	4	....	4	4	....	....	....	....	....	4
White Point	....	....	....	....	6	....	6	6	....	....	....	....	....	6
Total	3	1	70	15	42	6	137	75	....	33	8	15	6	137

Apparatus and capital.

Fishing center.	Boats.		Gill nets.		Bag nets.		Haul seines.		Lines and trawls.		Crayfish pots.		Total capital invested.
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No. of hooks.	Value hooks and lines.	No.	Value.	
San Pedro and Wilmington	36	$7, 250	35	$1, 050	3	$375	*9	$1, 260	....	$510	40	$60	$10, 505
Santa Monica	4	500	7	200	....	....	....	....	....	50	....	......	750
Alemidos Bay......	2	600	7	200	....	....	....	....	....	25	....	....	825
Newport Landing..	5	1, 500	10	300	...	....	....	......	....	75	....	....	1, 875
Santa Catalina Island	12	300	10	300	....	....	....	....	....	120	..	......	720
Portuguese Bend ..	6	230	...	....	..	....	....	....	....	....	50	75	305
White Point........	4	130	4	100	....	....	....	....	....	50	50	75	355
Total	69	10, 510	†73	2, 150	3	375	9	1, 260	41, 500	830	140	210	‡15, 335

* Length, 5,400 feet. † Length, 18,250 feet.
‡ In addition to this amount $500 were invested in shore property in this county.

Products and values.

Fishing center.	Fresh fish.		Dried fish.		Crayfish.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
San Pedro and Wilmington......	498, 838	$20, 940	....	....	150, 460	$3, 761	649, 298	$24, 701
Santa Monica.....................	60, 000	2, 400	....	....	....	....	60, 000	2, 400
Alemidos Bay.....................	70, 000	2, 800	....	....	....	....	70, 000	2, 800
Newport Landing................	175, 000	7, 000	....	....	....	....	175, 000	7, 000
Santa Catalina Island............	....	....	*100, 000	$5, 000	....	....	100, 000	5, 000
Portuguese Bend..................	....	....	....	....	(†)	....	....	....
White Point........................	(‡)	....	....	....	(†)	....	....	....
Total............................	803, 838	33, 140	100, 000	5, 000	150, 460	$3, 761	1, 054, 298	41, 901

* Including barracuda, bonito, jewfish, and whitefish, all shipped to San Francisco from San Pedro.
† These are sold at San Pedro and are included in the figures at that place, owing to the difficulty of accurately separating the catch of the fishermen in the different places. The approximate figures for the three localities are: San Pedro and Wilmington, 43,000 pounds; value, $1,070. Portuguese Bend, 53,000 pounds; value, $1,320. White Point, 54,460 pounds; value, $1,371. Total, 150,460 pounds; total value, $3, 761.
‡ Included with figures for San Pedro, where the fish are sold.

Fish trade of San Pedro and Wilmington.

Species.	Pounds.	Price per pound.	Value paid by dealers.	Species.	Pounds.	Price per pound.	Value paid by dealers.
		Cents.				*Cents.*	
Barracuda	125, 500	3	$3, 765. 00	Pompano	700	30	$210. 00
Bonito	6, 250	3	187. 50	Rock bass.........	4, 500	5	225. 00
Crayfish	150, 460	$2\frac{1}{2}$	3, 761. 50	Rockfish	18, 130	5	906. 50
Croaker	11, 250	5	562. 50	Sardine...........	5, 140	3	154. 20
Flounder	7, 175	7	502. 25	Sea bass..........	4, 500	5	225. 00
Grouper	8, 500	5	425. 00	Smelt.............	75, 360	5	3, 768. 00
Halibut............	8, 360	7	585. 20	Whitefish	172, 073	$4\frac{1}{2}$	7, 743. 28
Jewfish............	30, 450	3	913. 50	Yellow-tail	5, 500	4	220. 00
Mackerel	7, 125	3	213. 75				
Perch	8, 325	4	333. 00	Total	649, 298	....	24, 701. 18

NOTE.—Shipped to interior by express, 423,298 pounds; by teams, 200,000 pounds; sold locally, 26,000 pounds; total, 649,298 pounds.

15. FISHERIES OF VENTURA COUNTY.

Geographical characteristics, etc.—Ventura County lies between Los Angeles and Santa Barbara Counties, and has a coast line of about 36 miles, with a northwesterly trend. It has no harbors nor any large bays or important indentations. Along the coast is a narrow and more or less sandy plain, which is bordered in the rear by high mountains. The lofty Santa Monica Mountains form the border line between this and Los Angeles County, the ridge running down to the shore and terminating in two rough rocky headlands called Point Duma and Point Conversion. In a similar manner the county is separated on the north from Santa Barbara County by a spur of the Santa Inez Range, which ends at the sea in the bold headland of El Ricon.

According to Jordan, the Ventura River (Santa Clara River on some of the maps), which flows through the county, is the southernmost river in California that is not alkaline at its mouth. Therefore, although brook trout occur "in the headwaters of the Los Angeles and San Luis Rey Rivers, and even in some streams in the San Jacinto Mountains, in San Diego County," the salmon does not enter any river south of this.

Coast towns and fisheries.—Huenema and San Buenaventura are the only coast towns. The fisheries in this county have never been important. In 1880 Jordan records that there was at San Buenaventura "but one professional fisherman, who has in his possession two gill nets and one seine." He learned that there was a small party of Chinamen at Point Magu, 9 miles south of Huenema, who combined the labors of fishing and gardening, while a few Californians and Chinese fished from the wharves at San Buenaventura, and two or three farmers at Laguna Ranch occasionally operated a seine. The county is now without a single professional fisherman, so far as could be learned. A few individuals may occasionally catch a small number of fish for their own use—possibly any surplus may be peddled in the towns or surrounding country; but such operations are carried on in such a desultory and unsystematic way that they do not assume the importance of commercial fishing. Ventura County has in reality no fishery interests; and its short coast line, lack of shelter for boats, and the general character of its shores hold forth little promise for the future.

16. FISHERIES OF SANTA BARBARA COUNTY.

Geographical characteristics.—The coast line of this county, exclusive of the islands, is upwards of 100 miles in length. From Ventura County the coast extends almost due west to Point Conception, thence northwesterly to Point Arguello, where it turns sharply northward, the trend of the shore from this point to its junction with San Luis Obispo County being almost due north. Along the south coast, between the mountains and the sea, there is, over a long section, a belt of rather fertile land, with stretches of smooth, sandy beaches, occasional rocky shores, with

few indentations or lagoons. Bordering the shore, about half a mile distant from the land, is a kelp bed with an average width of upwards of 400 fathoms.

Stretching parallel with the coast, at an average distance of about 20 or 25 miles, is a group of rocky islands, some high, rugged, and mountainous, and all irregular in outline. These are the islands of San Miguel, Santa Rosa, Santa Cruz, and Anacapa. Santa Barbara and San Nicholas lie farther out, about 70 miles from the town of Santa Barbara. San Miguel is one of the smallest, being 6½ miles long and 2½ miles in extreme width. Santa Rosa is about 13 miles long by 9 miles wide, and contains about 50,000 acres; it is 27 miles southwesterly from Santa Barbara. Santa Cruz lies to the east of Santa Rosa, and is about 20 miles distant from Santa Barbara. It is 20 miles long and its extreme width is about 5 miles. Off its eastern end is the small island of Anacapa. Between the first four and the mainland is Santa Barbara Channel, an important fishing ground for surface-swimming species. The water is deep, however, and not suited to bottom fishing. These islands bear an important relation to the future development of the fisheries of this region, as will be seen further on.

Santa Barbara is a noted summer watering-place, located on a beautiful, slightly crescent-shaped shore, with a long, sloping sandy beach, and stretches of high hills along its sides. A long pier built on piles is a landing for steamers here; it extends into the bay opposite the town, and affords facilities to the fishing boats that they could not find on the beach, where the water is shallow and the surf breaks with considerable force except in the mildest weather. A wharf was first built in 1868, but the railroad did not enter the town until 1887. The bay is exposed to southerly winds, from the west nearly around to the opposite point, but affords a good shelter when the wind is north of east or west, as is usually the case during a greater part of the year.

Nearly parallel with the beach, and distant from one-third to one-half mile, is a broad belt of giant kelp that floats at the surface, and is so dense that channels have to be cut through it for the steamers. This serves the purpose of a breakwater, when the wind is from southwest to southeast, and makes it possible for the fishing boats to ride safely and with comparative ease at anchor when otherwise they would have to be hauled out on the beach or hoisted to the wharf, at great additional labor to the fishermen.

Fishing centers.—The only town in this county that can at present be considered a fishing center is Santa Barbara. In 1880, when Professor Jordan visited this region, some fishing was prosecuted from Goleta, and one man occasionally fished from the wharf or with a drag seine at Carpenteria, where fishing smacks were also built. For many years crews of Italians and Portuguese located at Goleta Point and near Point Conception to prosecute the whale fishery; but notwithstanding whales are still reported to occur in this region, the fishery

was given up some time ago, chiefly because of the low price of oil.* Individuals may occasionally go out for a day's fishing at some other point on the coast, simply for sport or to get supplies for their own tables, but irregular and desultory operations of this kind can not be considered in this connection.

Importance of the fisheries.—Notwithstanding there is no lack of variety or abundance of fish, little attention is given to the fisheries. The business is confined entirely to a small-boat shore fishery, practically controlled by one Italian and one Hungarian, who own nearly all of the boats and fishing gear, and hire other fishermen to go out when the latter are disposed to engage in fishing. As at many other watering-places, the fishermen find it most profitable to serve the pleasure-seekers who frequent this resort, and they engage in fishing only when they can not find other and more lucrative employment. Nevertheless, there has apparently been a moderate increase in the fisheries of the vicinity of Santa Barbara since 1880, though the county as a whole shows a slight decrease. The change is most noticeable in the number of boats employed, there being 24 in 1888 against 5 recorded by Jordan in 1880.

Species, abundance, seasons of occurrence, etc.—The following is a list of the most common and important species that constitute objects of fishery in this county, or which may become commercially important in the near future. Among the latter whales are perhaps the most important.

Sea otter (*Enhydra marina*).
Winter sea lion (*Zalophus californianus*).
Hair seal (*Phoca*).
Whales (chiefly *Rhachianectes glaucus*).
Barracuda, April to November.
Spanish mackerel (*Sarda chilensis*), most of the year.
Mackerel, May to November.
Rockfish (genus *Sebastichthys*), all the year.
Bluefish (*Girella nigricans*), all the year.
Whitefish, all the year.
Halibut (*P. californicus*), all the year.
Smelt, May to November.
Sardine, May to November.
Eel (*Anguilla*), not common.
Yellow-tail, all the year.
Rock bass, May to October.
Kingfish, all the year.
Black perch (family *Embiotocidæ*), all the year.
Red perch, all the year.
Jewfish, all the year.
Pompano, June to September.
Mullet.
Horse mackerel.
Roncador.
Fat-head.
Flying-fish.

Besides the above there are sharks, dogfish, skates, sculpins, and numerous other varieties. Crayfish and abalone may be taken throughout the year. Sea otters occur rather sparsely about the islands, and are hunted there during the fall and most of the winter by native Californians from Santa Barbara, who, during the rest of the year, generally engage in pelagic fur-sealing on vessels sailing from San Francisco. These men return from sea in October and shortly thereafter camp upon the islands, where they also take hair seals for their oil and pelts, and

* Goleta had been abandoned in 1880, but there was then a whaling company of 20 men at Cajo Viejo, 51 miles west of Santa Barbara; this has also been deserted.

occasionally capture a live seal or sea lion, to sell for exhibition purposes. The sea otter is excessively shy here as elsewhere, but the great value of its pelage is an incentive for the hunter to endure long periods of patient waiting and much exposure.

Whales, chiefly the California gray, are reported to be numerous off the coast of this county during the winter, when they frequently come close inshore. In summer they migrate northward. None have been captured, however, in recent years, but quite an important shore whale fishery could be prosecuted, as in former years, if the price of oil should advance sufficiently to make the business remunerative. The profits might now be materially enhanced by the utilization of the carcasses for the manufacture of fertilizer—a product that ought to find a ready sale at good prices.

Barracuda, bonito (commonly known here as "Spanish mackerel" and "skipjacks"), and smelt are the leading varieties of market fish during the summer. Bull's-eye mackerel are moderately abundant and can be taken from May to October.* They are not much esteemed, however.

Albicore, sea bass, yellow-tail, and jewfish are caught in summer.

Crayfish, an important species in this locality, are very numerous, and can be taken at all seasons, though somewhat farther offshore in winter than during the warm season, when they can be taken close inshore.

The abalone is somewhat less abundant on the islands than formerly, but it is still numerous. The unremunerative prices now obtained for the shells deter white men from engaging in the fishery for them. This cause has had more to do with the seeming decline in this fishery than any real scarcity of the species. Only the largest and finest shells are now marketable; tons of slightly inferior quality, that formerly would have brought good prices, are now thrown away. The result is that the abalone fishery has of late come entirely under the control of the Chinese, who, content with small returns, scour the coast in their junks, gleaning whatever of nature's bounty they can secure, for which any market can be found.

The native Californians sometimes eat a few clams, of which there are two or three species; but there is no clam fishery. Oysters and scallops are not taken.

Fishing grounds.—A favorite fishing ground for surface species (barracuda, bonito, etc.), and one of the best on the coast of California, is in the channel between Santa Barbara and the islands (see map, plate I). The rocky ledges that jut out from the land, intersecting the long stretches of sandy beaches and shallow inshore bottoms, are considered excellent fishing grounds. Along the shore, between Los Pueblos and Carpenteria, is said to be one of the best localities for hook-and-line fishing on the coast of this county. There are excellent grounds for

*Alexander says the bull's-eye does not occur anywhere along this coast in abundance to be compared with the common mackerel in the Atlantic.

gill-net and line fishing about the islands of Santa Rosa and Santa Cruz.

Fishermen.—There are only 15 persons in this county, including the seal and sea-otter hunters, who may properly be called fishermen. Of these 8 are natives of foreign countries (including 1 Chinaman) and 7 are native Californians.

Boats.—The little fleet of fishing boats sailing from Santa Barbara are all less than 5 tons burden. They are mostly sailboats, as follows: 1 sloop, worth $600; 8 lateen-rigged feluccas, averaging about $112 each; and 8 sprit-rigged boats with an average value of $100. Besides these there are 7 small rowboats with a total value of $75.

Apparatus of capture.—Gill nets are employed chiefly in winter time, when the fish have moved off into comparatively deep water. They are set at the islands and along the shores of the mainland. The nets are commonly about 40 fathoms long, 15 feet deep, and have a mesh varying from less than 2 inches to 3 inches. Thirty-five nets are used, of which 10 are classed as bass nets, 11 as smelt nets, and 14, with a mesh of 3 inches, have no special classification.

Fourteen trammel nets are used. They are preferred for some kinds of fishing, because fish of varying sizes can be taken in them.

Three small shore sweep seines, with an average value of $100, are used at Santa Barbara. These average 50 fathoms in length, 2 fathoms in depth, and have a ½ inch mesh. They are operated in the shallow water along the beaches.

Trawl lines are used for rockfish about Richardson's Rock, on the ground west of San Miguel Island, and also south of Anacapa Island. (See map, plate I.)

Troll lines similar to those already described (page 30) are used to capture barracuda, bonito, mackerel, etc., in Santa Barbara Channel.

In winter a hook-and-line rig is often operated from the wharf at Santa Barbara, and sometimes this gear is used in the kelp beds.

In summer, when the crayfish are abundant near the shore, a hoop net or bag net (locally called a "crayfish trap") is used. But in winter, when the "rock-lobster" is farther offshore in deep water, the regular crayfish pot, made of laths, is preferred. The "trap" is essentially the same form of apparatus as the "hoop net" formerly used in the New England lobster fisheries. It consists of a net bag hung to an iron hoop, so that it will have a depth in the center of about 3 feet, which is equal to the diameter of the hoop. Crossing this hoop at right angles, and arching above it with a moderate curve, are two wooden hoops seized together where they intersect, and having their ends securely fastened to the iron. Attached to the wooden hoop at the point of intersection is a string for fastening the bait, and sometimes this is provided with a hook. A triangular bridle of line is attached to the iron hoop and the buoy line is bent to the bridle where the several parts unite. This bridle is so arranged that when the fisherman pulls upon the buoy line the

trap is lifted so that the iron hoop hangs horizontally and can be pulled up in this way without danger of spilling the contents of the bag.*

Methods of fishing.—The methods of fishing, so far as they apply to the use of gill nets, drag seines, troll lines, and trawl lines, are essentially the same as in other localities. It need only be said that in all hook-and-line fishing crayfish are the most tempting bait. Brief allusion may, however, be made to the method of fishing with the hoop "traps" for crayfish. These are set in shallow water inside the kelp beds that fringe the coast. Almost anything in the shape of fish answers for bait, but bonito is believed to be most attractive to the rock-lobster. The location of each trap is marked by a small buoy attached to the top end of the buoy line, which bobs up and down on the waves at the surface. When set, the net lies loose and flat on the bottom, with the iron hoop resting upon its edge, while the bait hangs over the center. There is nothing to prevent the crayfish from escaping after they have eaten the bait, though it is natural for them to lie upon the net beneath the lure until they have consumed it. For this reason the fishermen carefully watch their nets, rowing along from buoy to buoy, peering down over the boat's side into the water to see if any crayfish are in the traps. If one is seen on the net it is quickly pulled up and, being prevented from escaping by the depth of the bag, is taken into the boat and the trap is reset, new bait being put on if necessary.

Sea otters, seals, and sea lions are killed by shooting them; the use of firearms about the islands has a tendency to increase the remarkable natural shyness of the sea otter and to render its capture more difficult.

Preparation of products, markets, and shipments.—The fish are mostly sold fresh; a few are dried in the fall and early winter and shipped to San Francisco. The abalone meats are dried, and the shells prepared in the ordinary way. These are taken by Chinese in junks from San Diego or San Francisco; but, as the shells are obtained in this county and shipped from Santa Barbara, the products have been included here, and are additional to what has been credited to the junks.

Seal oil is tried out by the fishermen; it is worth only $10 a barrel.

Most of the fish are consumed locally. The majority of those not taken by the local trade are sent to San Francisco in a fresh condition. A large percentage of the crayfish go to this market; but the demand for crayfish appears to have greatly decreased since 1880, when, according to Jordan, Santa Barbara supplied nearly all the demand for this crustacean at San Francisco, and the catch was about ten times as much as now, or a total of 90 tons per annum.

The want of a convenient market is severely felt by the fishermen. It is thought that a good demand could be created along the line of the railroad connecting Santa Barbara and Los Angeles if effort were made

* The same result was obtained with the New England lobster net by using a single line bent to the wooden hoops where they cross each other. This is a simpler and cheaper method.

to properly dress and preserve the fish before shipment. A trade in salt or dried fish could, no doubt, also be inaugurated.

The following tabulated statements show in detail the statistics of the fisheries and fish trade of Santa Barbara County for 1888:

Persons employed.

Country.	Nativity.	Nationality.
United States	7	7
Austria	4	4
Italy	3	3
China	1	1
Total	15	15

Apparatus and capital.

Designation.	Number.	Value.
Boats	24	$2,375
Gill nets	*21	720
Trammel nets	14	560
Haul seines	3	300
Trawl lines	†22	77
Crayfish pots	60	120
Shore property	....	300
Total	....	4,452

*5,800 feet in length. † These were provided with 3,500 hooks.

Products and values.

Species.	Quantity.	Value.
Fresh:		
Barracuda ... pounds	16,000	$800.00
Bonito ... do	25,000	1,250.00
Sea bass ... do	20,000	1,000.00
Rockfish ... do	18,000	900.00
Smelt ... do	7,000	350.00
Mackerel ... do	2,000	100.00
Other fish ... do	2,320	116.00
Crayfish ... do	19,200	960.00
Abalone meats ... do	34,050	2,043.75
Abalone shells ... do	19,775	247.18
Dry fish ... do	6,325	316.25
Total	169,670	8,083.18
Hair-seal skins ... number	650	650.00
Sea-otter skins ... do	25	2,500.00
Live seals ... do	16	400.00
Seal oil ... barrels	11	110.00
Total	....	3,660.00
Grand total	....	11,743.18

Monthly shipments from Santa Barbara County to San Francisco by the Pacific Coast Steamship Company, in 1888.

Month.	Dry fish.	Fresh fish.	Abalone meat.	Abalone shells.	Live seals.	Seal skins.	Seal oil.	Crayfish.*
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*No.*	*No.*	*Bbls.*	*Lbs.*
February		220		1,010	8			
March				3,180				
April					4			
June		1,600			4	246		
July		260				354	9	
August			15,730					
September			15,440	13,525				
October	2,625							
December	3,700		2,880	2,060		50	2	
Total	6,325	2,080	34,050	19,775	16	650	11	12,000

* Dates of shipments of crayfish not given.

17. FISHERIES OF SAN LUIS OBISPO COUNTY.

Geographical features.—The coast line of San Luis Obispo County has a general direction about NNW. and SSE. and is 80 miles long in a straight line. It is, however, irregular in contour and would measure considerably more by following the curve of the bays of San Luis Obispo, Esteros, and San Simeon, which indent the shore. There is no harbor, and the nearest approach to one is the "one-sided" shelter at Port Harford, on the north side of San Luis Obispo Bay, where there is a long pier at which the coast steamers touch to connect with the railroad. A breakwater is being built at Point San Luis, as a protection to Port Harford, and it is expected this will extend seaward a mile or more in a southeasterly direction. Port Harford is the only railroad terminus on the coast of this county; it is about 198 miles (by sea) from San Francisco, and is the port of San Luis Obispo, a thriving town of about 4,500 inhabitants, 10 miles inland. Being the principal point from which fish can be conveniently shipped to the interior, or to San Francisco, it is the center of the limited food-fish fishery, and there is no other fishing station in the county except at San Simeon Bay, 38 miles northwest of Port Harford, where whaling is prosecuted and where one man catches a few smelts and rockfish that are sent to San Francisco by steamer.* The coast is high and broken in sections, but there are long stretches of sandy beaches, with shallow spits or reefs extending into the sea, which uncover at low tide and upon which native clams occur in abundance.

Importance of the fisheries.—The fisheries of this county are not important at the present time. It is reported, however, that fish occur in great variety, and even more abundantly than farther south. There is apparently no lack of supply, and for this reason the fishing interest is capable of material advancement and may reasonably be expected to keep pace with the increase of population; while still greater improvement may be anticipated if desirable changes in methods are adopted, which will tend to a wider distribution of products.

* The fisherman at San Simeon Bay is one of the whaling crew at that station, and fishes for food species when not engaged in whaling.

Compared with the figures obtained in 1880, there has been a very gratifying increase in the product and value of the food-fish fishery. In 1880 the yield of food-fish obtained in this county, exclusive of shell-fish and crustaceans, amounted to 84,000 pounds, with a value of $2,520. In 1888 the product was 129,627 pounds of fresh fish and 10,000 pounds of salt fish, with an aggregate value of $4,482.81. There has been, however, a material decrease in the whale fishery, which will be more fully discussed in a succeeding paragraph.

Species, seasons of occurrence, etc.—The species here do not vary materially from those given under the head of Santa Barbara County, and there is practically no difference in those most important for food purposes. In the following notes special mention is omitted of species of secondary importance.

Mackerel were not known to enter San Luis Obispo Bay till 1887, during which and the following year the species was very abundant in August, September, and October, at times appearing in large schools. In 1888 the first fish were taken on August 10 and the species remained well into November. They averaged nearly 3 pounds in weight.

Barracuda are chiefly taken in July, August, and September, but are also caught between February and December. They average 6½ pounds, some reaching 12 pounds. Small fish occur throughout the winter.

The sea bass is one of the most important species of the county, as it is of the entire State. During August and September, 1888, they were very abundant, and they were also taken, in smaller numbers, in October and November. They weigh from 3 to 75 pounds, averaging about 20 or 25 pounds. They arrive in schools containing fish of uniform size and resort chiefly to the kelp beds along the shore.

Bonito and horse mackerel occur at the same season and under about the same conditions as the barracuda. Rockfish of numerous varieties are taken in greater numbers than any other species, and constitute about one-third of the entire catch. Bastard halibut (*P. californicus*), of from 10 to 60 pounds, are taken near the wharf at Port Harford, but are not abundant. Smelts reach this part of the coast in March and become abundant during summer and fall; a few remain all the year. Sardines and herring arrive after the main body of smelts, and both are taken with set and drift gill nets. Pompano, kingfish, perch, blue-fish, and other varieties are caught in small quantities. Shad have not been seen in this county so far as could be learned.

Whales appear chiefly in fall and winter, as on other parts of the coast south of San Francisco. Four species, the humpback, California gray, finback, and sulphur-bottom, are said to occur, but only gray whales were taken in 1888. These are about 35 to 40 feet in length, and yield about 25 or 30 barrels of oil.

Clams are plentiful on the shallows bordering the beaches, but they are not taken in large numbers. Abalone shells occur on the rocky shores, but are not numerous; only a few are incidentally taken.

Fishermen and shoresmen, lay, etc.—There was a total of 25 fishermen in this county in 1888, representing many nationalities. One native of New England, who had been trained in the arts of a fisherman on the coast of Maine, has established his home on a small rocky islet (near Port Harford) that rises 50 or 60 feet above the sea, its naked wind-swept sides and crest barren of vegetation. Besides Americans, there are natives of five European nations. Portugal and Norway are most numerously represented. Russia comes next with two men, while there is a single fisherman each from Great Britain and Denmark. In addition, there are two American-born shoresmen who find occupation in marketing or shipping the products.

There is practically no lay in the food-fish fishery, since the fishermen own their boats and equipment, and all that is received for fish, etc., belongs to them. The lay of the whalemen at San Simeon Bay, according to Alexander, is as follows: The harpooner receives one-sixteenth of the proceeds and each member of the crew gets one-fiftieth. Only two of the men remain at the station during summer to look after the boats, gear, etc., for which some allowance is probably made.

Boats.—There is nothing very distinctive about the boats used in this county; 19 are employed; 2 are small sloops, each less than 5 tons; 8 are cat-rigged, and 9 are whaleboats of the ordinary type employed in shore whaling; 3 of the latter are fitted with a pivot gun at the bow in addition to the ordinary equipment of a whaleboat. Each boat is valued at $200, including oars, besides which she has the following equipment: Harpoon gun (swivel, English make), worth $120 (cost $200 new); bomb gun (American make), value $50; bombs, $25; whale line, $125; sundries (including hand lances, harpoons, etc.), $80.

Fishing grounds, apparatus, methods, etc.—Mackerel are caught chiefly near the shore, for a mile or two on either side of Point San Luis, and around the whistling buoy, about a mile southeast from the point, in from 13 to 17 fathoms of water. The New Englanders have introduced the method of jigging mackerel, and it has proved successful; most of the mackerel taken are caught this way. The jigs are similar in form and construction to those used in catching the common mackerel (*S. scombrus*) in the Atlantic, but are much larger.

The principal trawling grounds for rockfish are in San Luis Obispo Bay, in 6 to 12 fathoms, from ½ to 2 miles or more from shore, and along the coast north of Point San Luis, in 11 to 18 fathoms, on a variable bottom consisting chiefly of gravel, broken shells, and spots of barnacles. Rockfish are also caught to a less extent with hand lines on these grounds. The favorite fishing grounds for bass is on the east side of San Luis Obispo Bay, in from 2½ to 5 fathoms, where gill nets are set in and near the kelp beds frequented by this genus. Bass are also taken in drift nets farther out, as are bonito, mackerel, and horse mackerel. The two latter species, as well as the barracuda and some others, are caught by trolling with hook and line, but apparently to a less extent

than by nets. Bastard halibut are caught in limited numbers close inshore between Point San Luis and Port Harford wharf.

San Luis Obispo Creek empties into the bay of the same name east of Port Harford. The stream is shallow and unimportant, but a few herring are taken in it with gill nets, and occasionally a salmon is caught; but the capture of salmon is comparatively so rare and so entirely an incident of the fisheries that no reliable statistics could be obtained.

The principal clam grounds are on the beach, nearly 10 miles long, on the east side of San Luis Obispo Bay, at and near Pismo Landing, a long pier 7 miles east of Port Harford. On Esteros Bay, about 15 miles (by sea) northwest of Port Harford, is another excellent clam ground, but no clams are dug there except by ranchers living in that locality, who supply their own tables. A fresh-water stream empties into the bay at this point, and the locality has been spoken of as a good site for the cultivation of oysters. In addition to the clams dug on these beaches by the ranchmen, two men make a business of digging and peddling their products through the interior, selling at $1.50 to $2 per 100 clams.

The shore whale fishery.—San Simeon Bay and vicinity and about "Whalers' Point," near Port Harford, have been considered the best grounds in this county for whaling. Whales are said to be scarcer than formerly along this section of the coast. It is believed by some of the old fishermen that this scarcity is to some extent due to the presence of steamers on the coast.

From 1869 to 1887 a shore whaling station was maintained at Whalers' Point, where, it is said, as many as 30 or 40 whales were taken in the most prosperous seasons. But in 1887, the last year of the fishery at this place, only 5 whales were captured. The scarcity of whales, together with the low price of oil, contributed to the abandonment of the station. The whaling company here consisted of 20 men, who operated 3 boats manned by 6 men each. In 1880 there were 21 men.

A whaling station was established at San Simeon Bay in 1865 by a man who had formerly engaged in this fishery at Monterey, San Diego, and Portuguese Bend. The business has been continued, with, perhaps, temporary intermissions, until the present time. Between 20 and 30 whales have often been taken in a season, and an average of 17 for the first 16 years. This station, as well as the other shore whaling stations along the coast, was reported as closed during the early part of 1888, but was reopened in the fall, and up to March 9, 1889 (at which time the fishery was suspended), 14 whales had been taken, which yielded 440 barrels of oil, valued at $5,720.*

* In the tabulated statement the amount and value of oil obtained in the calendar year ending December 31, 1888, is given. The products and values for the season are more correctly represented by the figures stated above. The whales captured prior to December 31, 1888, were comparatively small, seven of them yielding only 180 barrels of oil, while the same number of "fish" taken between January 1 and March 9, 1889, produced 260 barrels of oil.

There are 9 whaleboats, of which a certain number are kept ready and fully equipped for immediate use, the others being held in reserve to supply the place of a "stove boat," to assist in towing dead whales to shore, or to render any other necessary service.

The season is from November to the middle of March, after which date the whales have generally left the coast on their annual migration north.* The species taken here is usually the gray whale; the hump-back or "summer whale" is rarely captured, and the same may be said of the right whale. The best success is usually met with in the early part of the season, when the whales are going south, for in the late winter and spring, when returning, they keep farther off shore, and the prevailing northerly winds and rough sea often prevent their successful pursuit. Besides, as they are then in poor condition, there is not the same inducement to hunt them.

Organization of whaling camp, methods, etc.—Captain Scammon writes as follows:

The organization of each party is nearly on the same plan as that of the whale ship's officers and crew, all being paid a certain share, or lay, which corresponds to the position or individual services rendered by each member. A "whaling company," as it is termed, consists of one captain, one mate, a cooper, two boat-steerers, and eleven men; from these, two whaleboats are provided with crews of six men each, leaving four men on shore to take their turn at the lookout station to watch for whales and to tend to boiling out the blubber when a whale is caught. The stock of the company consists of boats, whaling implements, and whaling gear, which is divided into sixteen equal shares, and the "lay" of each member is the same. The captain and mate, however, are paid a bonus of $200 or $300 for the term of the engagement, which is 1 year, and they are also exempt from all expenses of the company.

The cruising limits of the local whalers extend from near the shore line to 10 miles at sea. At dawn of day the boats may be seen careening under a press of sail, or propelled over the undulating ground swell by the long, measured strokes of oars, until they reach the usual whaling ground, where the day is passed plying to and fro, unless the objects of pursuit are met with. * * * Generally whales are first seen from the boat, but occasionally they are discovered by the man on watch at the station, who signals to the boats by means of a flag elevated upon a pole with which he runs toward the quarter where the whales are seen; or a series of signals is made from a tall flagstaff.

The cetaceous animals frequenting the coast, having been so long and constantly pursued, are exceedingly shy and difficult to approach, and were it not for the utility of Greener's gun the coast fishery would be abandoned, it being now next to impossible to strike with the "hand harpoon." At the present time (1874) if the whale can be approached within 30 yards it is considered to be within reach of the gun harpoon. When the gunner fires, if he hits the game, the next effort is to haul up near to shoot a bomb lance into a vital part, which, if it explodes, completes the capture; but if the first bomb fails, the second or third one does the fatal work. The prize is then towed to the station, and, if it be night, it is secured to one of the buoys placed

*Alexander states that "December, January, and February are the months in which whales frequent this locality; sometimes, however, a few are seen as late as the middle of March. These months are called the "down-run" season; the "up-run" is of short duration, which, as a rule, lasts from 4 to 6 weeks. Whales when migrating north are poor, but on their return south are invariably fat and contain about 50 per cent. more oil than when on their northern passage."

for the purpose, a little way from the surf, where it remains until daylight or until such time as it is wanted to be stripped of its blubber. The whales generally taken by the shore parties are humpbacks and California grays; but occasionally a right whale, a finback, or a sulphur-bottom is captured. (Marine Mammalia, pp. 247–250.)

The difficulty of killing the finback, and the fact that it has only a thin coating of blubber and yields but a small amount of oil, deter the whalemen from attempting its capture, though it is reported to be abundant. The sulphur-bottom is also said to be fairly numerous in recent years, but it is the most dangerous to attack and the hardest to kill. The whalemen do not like to fasten to whales of this species, and their capture is attempted only when they can be approached near enough to shoot bomb lances into them.

Usually the whales are stranded upon the beach, where they are held in the edge of the surf, while the process of flensing or "cutting-in" (stripping off the blubber) is performed. The blubber is taken off in large oblong flitches or square pieces, one or more men standing upon a whale and cutting vigorously with sharp spades. When one side is stripped, the animal is rolled over by tackles. (See plate III.)

Captain Scammon thus graphically describes the scene at one of these shore whaling stations during the period when a whale is being "cut-in" and the process of "trying-out" is in full blast:

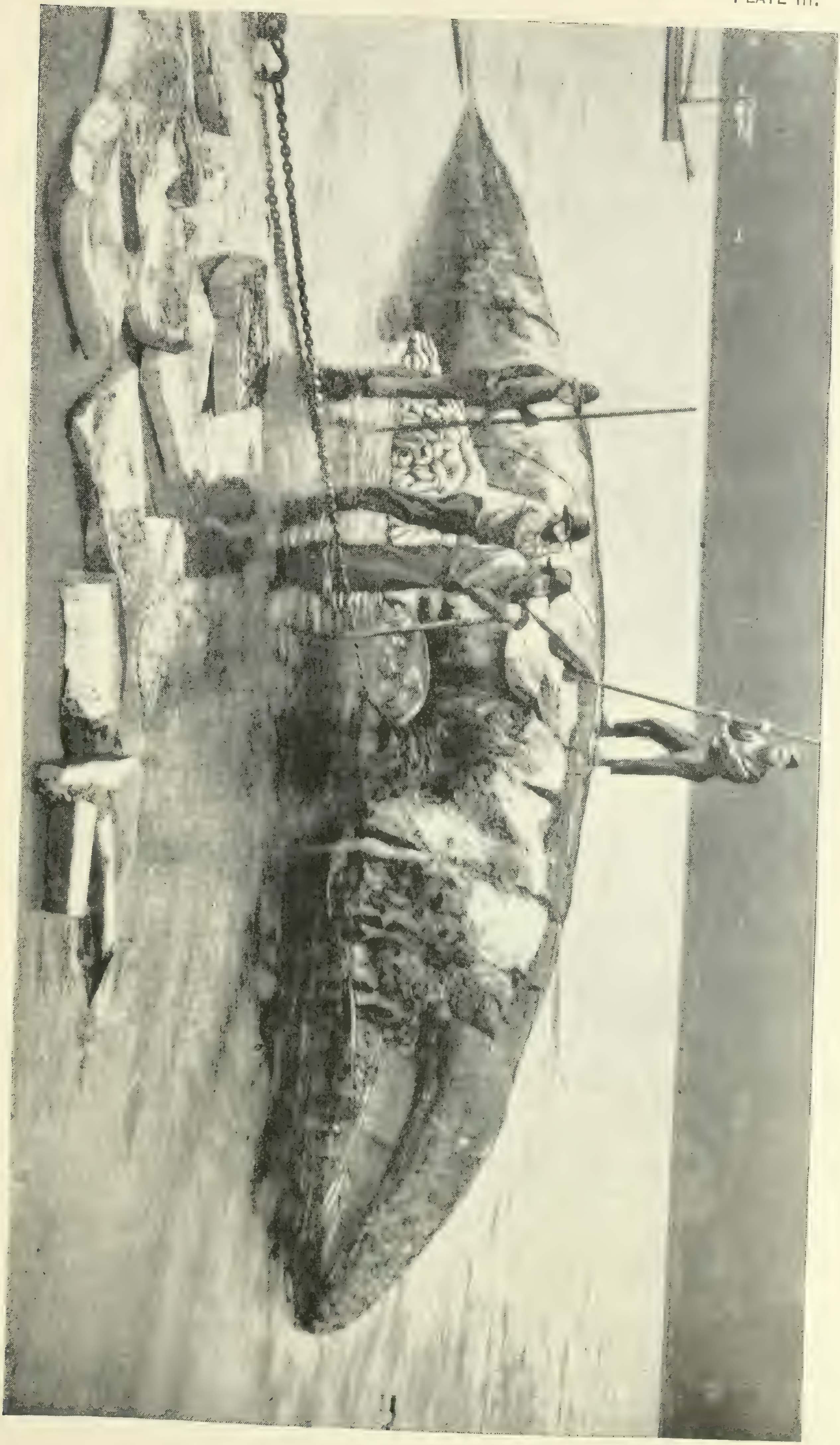
Near by are the try-works, sending forth volumes of thick black smoke from scrap fire under the steaming caldrons of boiling oil. A little to one side is the primitive storehouse, covered with cypress boughs. Boats are hanging from the davits, some resting on the quay, while others, fully equipped, swing at their moorings in the bay. Seaward, on the crest of a cone-shaped hill, stands the signal pole of the lookout station. Add to this the cutting at the shapeless and half putrid mass of a mutilated whale, together with the men shoving and heaving on the capstans, the screaming of gulls and other sea fowl, mingled with the noise of the surf about the shores, and we have a picture of the general life at a California coast whaling station. (Marine Mammalia.)

Preparation of products, markets, etc.—The greater part of the food-fish products of this county is marketed fresh, but a portion is salted; the quantity so prepared in 1888 was 10,000 pounds. Among the cured fish may be included mackerel, some of which are salted and dried as cod are. The fact that the Pacific mackerel are not fat or oily, as is usually the case with the common species, except in spring, renders it possible to cure them in this way. Other products, such as abalone shells, clams, etc., are prepared or marketed in the ordinary way.

The markets are San Francisco and the interior towns, notably San Luis Obispo. All the products of the whale fishery and the limited abalone fishery go to San Francisco, where also were sent 69,427 pounds of fresh food-fish, and 10,000 pounds of clams; 60,000 pounds of fresh fish, and 10,000 pounds of cured products were sold by peddlers, or shipped to the interior towns by rail. The salt fish are generally sold by peddlers to ranchmen in the vicinity of fishing stations.

The demand for fresh fish at San Luis Obispo and the other towns

PLATE III.



CUTTING IN A WHALE. SAN SIMEON BAY.

on the line of the railroad terminating at Port Harford is frequently in excess of the supply obtained by the few coast fishermen. But during the season when migratory species appear there is generally a surplus, which is shipped by steamer to San Francisco.

The following tables show in detail the principal phases of the fisheries and fish trade of San Luis Obispo County in 1888:

Persons employed.

Country.	Nativity.	Nationality.
United States	*6	*12
Portugal	12	8
Norway	5	3
Great Britain	1	1
Denmark	1	1
Russia	2	2
Total	27	27

* Including two shoresmen.

Apparatus and capital.

Designation.	No.	Value.
Boats	19	$2,500
Gill nets	40	2,000
Lines	......	125
Whaling outfit	......	800
Shore property	......	200
Total	......	5,625

*Products and values.**

Products.	Sold fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.
Rockfish	51,654	$1,550	....	....
Sea bass	37,763	1,133	2,500	$150
Barracuda	18,010	540	1,000	60
Mackerel	10,400	312	2,000	120
Bonito	....	....	3,000	180
Halibut (bastard)	2,000	60	....	....
Smelt	1,600	48	....	....
Horse mackerel	....	....	1,500	90
Other fish	†8,000	240	....	....
Abalone shells	1,240	20	....	....
Clams	10,000	900	....	....
Total	140,667	4,803	10,000	600

* The manufactured products consisted of 180 barrels of oil, valued at $2,340.

† Including herring, "sea trout," kingfish, and perch.

Shipments from Port Harford, California, during 1888.

Species.	By railroad and peddlers.		By steamer to San Francisco.
	Fresh.	Cured.	Fresh.
	Pounds.	*Pounds.*	*Pounds.*
Rockfish	45,000	....	6,654
Sea bass	3,000	2,500	34,763
Barracuda	1,000	1,000	17,010
Mackerel	2,000	2,000	8,400
Bonito	....	3,000	....
Halibut	....	....	2,000
Smelt	....	....	1,600
Horse mackerel	....	1,500	....
Abalone shells	....	....	1,240
Clams	....	....	10,000
Other fish	*8,000	....	....
Values	$1,800	$600	$3,003

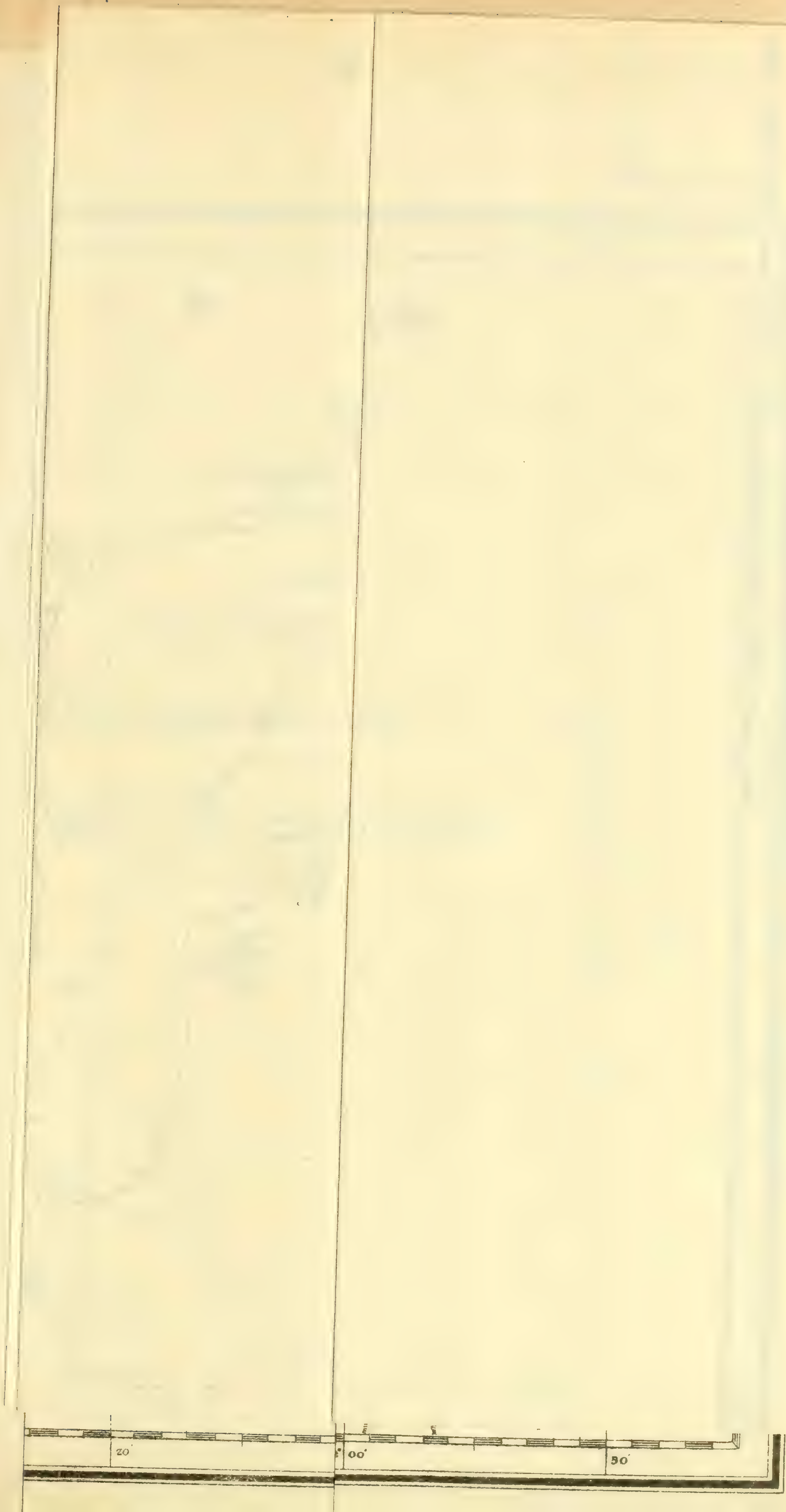
* Including herring, "sea-trout," kingfish, and perch.

18. FISHERIES OF MONTEREY COUNTY.

Geographical characteristics.—From its junction with San Luis Obispo County, the coast of Monterey County stretches away to the northwest to Point Sur in an almost unbroken line, without bays, harbors, or coast settlements. The high mountains of the Santa Lucia Range, which terminate at Point Carmel, run parallel with the shore, and being close to the sea they shut off the interior and render fishing impossible on this part of the coast. At Point Sur the shore line bends northward, but is still unbroken, to Point Lobos, north of which is Carmel Bay. This bay, the shores of which are subdivided into Stillwater Bay, Pescadero Beach, and Chinese Cove, is situated on the south side of the broad peninsula that separates it from Monterey Bay. Beyond Point Pinos, which marks the southern boundary of Monterey Bay, the shore makes a bold curve, sweeping southeasterly to Monterey and then turning sharply northward, the general trend of the coast being northeasterly to the limits of the county.

The coast north of Point Lobos is very broken; bold headlands and jagged rocky shores, bristling with sharp-pointed crags and wave-worn cliffs and bowlders, alternate with stretches of sandy beaches, from some of which comparatively level sections of land run back from the sea. In many places the scenery is very fine. The indentations referred to afford more or less satisfactory shelter to fishing craft, and make it possible to prosecute the fisheries from the northern end of the county. The lower end of Monterey Bay, opposite the town of Monterey, is sheltered from southerly and westerly gales by Point Pinos. It is exposed only to northerly winds, is generally a fair harbor, being the best-sheltered anchorage between San Diego and the Golden Gate. Carmel Bay is less favorably situated and affords a poor harbor, being exposed to southerly and westerly winds.

Fishing centers.—Monterey, an ancient mission town of about 1,500 inhabitants, and now a seacoast resort of some note, is the principal


20′
00′
50′


MONTEREY BAY TO SALT POINT, CAL
SHOWING THE
COAST FISHING GROUNDS.
SEASON OF 1888-89
TRAWL LINE
FISHING GROUNDS
TRAWL LINE
FISHING GROUNDS
See special chart SAN FRANCISCO BAY
TRAWL LINE
FISHING GROUNDS
TRAWL LINE FISHING GROUNDS
100 fathom curve
MONTEREY BAY
FISHING GROUNDS

fishing center of the county; it has many natural advantages for fishing, and is, besides, within easy reach of San Francisco by rail; the journey can be made in 7 hours; fish landed here in the evening are marketed at San Francisco the next day.

At Point Alones, about 1½ miles northwest of Monterey, is a large Chinese fishing village, composed of rude shanties; this "camp" was started in 1863, and appears to be one of the most thriving settlements of its kind on the west coast. At Pescadero, on Carmel Bay, is another Chinese fishing camp, but second in importance to the one at Point Alones; this was settled in 1868 and has a resident population of some 30 fishermen; it is picturesquely situated on a road that skirts the shore, and is within easy reach of the fishing grounds in Carmel Bay.

Species, abundance, migrations, etc.—Monterey Bay is celebrated for its abundance of fish, and is especially noted for apparently being the limit of migration for many species that occur north and south of this point. Of the many species of fish found in abundance farther south (especially the bonito, barracuda, mackerel, sea bass, horse mackerel, and pompano), few are ever seen in great numbers north of Monterey Bay. It is said that many northern species, among which the salmon is included, are generally rare south of this point, and are sometimes not to be found.

In 1889 mackerel and barra uda were quite plentiful as late as December 7. According to Alexander:

> The first-named species has never before been known to remain on the coast so late in the season; the 1st of September is, as a rule, about the time it leaves; after that date it is seldom caught. The Pacific mackerel, like the Atlantic species, are very erratic, and very little is known as to their migratory habits. Fishermen approximately foretell the arrival of other fish, but the movements of the mackerel are acknowledged to be too ambiguous for their comprehension.

The following list includes the principal species of fish in this county; there are, however, many other varieties that are caught occasionally, also squid, crustaceans, shellfish, etc.:

Name of species.	When found.
Rockfish; rock-cod (*Sebastichthys*)	All the year.
Flounders	Do.
Perch (*Ditrema* and *Holconotus*)	Do.
Bluefish	Do.
Kingfish	Do.
Stingray (*Myliobatis californicus*)	Do.
Sculpin; bull-head (*Leptocottus armatus* and *Scorpænichthys marmoratus*)	Do.
Sea bass	July to October.
Spanish mackerel	Do.
Horse mackerel	Do.
Chub mackerel	Do.
Whitefish	April to October.
Yellow-tail	Do.
Smelt (*Osmerus* and *Hypomesus*)	March to November.
Sardine (*Clupea sagax*)	April to November.
Bastard halibut	May to September.
Barracuda	July to November.
Sharks (*Rhinobatus*, *Galeorhinus*, and others)	All the year.
Skate (*Raia inornata* and *R. binoculata*)	Do.
Sea trout (*Hexagrammus decagrammus*).	
Mullet (*Mugil*).	
Pompano (*Stromateus*)	July to September.

The species taken in the hand-line and gill-net fisheries in the winter and spring are chiefly rockfish, flounders, smelts, sharks, kingfish, and sculpins; while barracuda, mackerel, sea bass, bonito, pompano, white-fish, yellow-tail, bastard halibut, horse mackerel, etc., are caught in summer, in addition to the other species just enumerated. Shad are rare in the waters of this county, only one being caught in 1888, but they are plentiful on the north side of Monterey Bay near Santa Cruz.

Sharks of several species are abundant; only the fins and tails are utilized; these are sold to the Chinese for 11 cents per set, or what is obtained from one fish. One swordfish (*Xiphias gladius*) was killed in 1888; the fishermen say this is the only one of this species ever seen or taken at Monterey Bay.

Whales are reported more numerous than they were a few years ago, but no attempt has been made to take them at Monterey Bay since 1881, and the shore whaling station at Carmel Bay was closed three years later. Sea lions are very plentiful in Monterey Bay and vicinity; they can be seen in large numbers at all seasons, hauled out on the rocky shores and ledges about Carmel Bay; they frequently damage nets, but have no commercial value and are not sought by fishermen.

Squid are abundant in their season, and constitute an important object of fishery of the Chinese, by whom alone they are taken. They arrive in large numbers in April and remain about two months. Occasionally a small catch is made in the fall. Shellfish are scarce or entirely absent. There are no scallops and only a few clams and abalones. The latter were once abundant, but are now nearly exterminated, little more than enough being obtained to supply the tourists visiting Monterey. Only a few are sent to San Francisco. There are no shrimp or crayfish taken. Lobsters appear to have been successfully introduced by the U. S. Fish Commission. Mr. Wilcox was told that specimens 4 to 6 inches long were occasionally seen, and that two were taken in February, 1889, which were immediately returned to the water by the fishermen.

Fishing grounds.—The fisheries are prosecuted almost exclusively in Monterey and Carmel Bays. The latter is resorted to by fishermen from Monterey, and especially by the Chinese at Point Alones, who unite their interests with the Chinese fishermen at Pescadero, to the extent at least that the residents of both villages ship their products together to San Francisco.

Mr. Alexander makes the following remarks concerning Monterey Bay in his report on the lobsters planted at that place:

> Stormy weather generally affects the movements of all species of fish in the bay. On the first approach of a storm they leave their favorite feeding grounds and seek deeper water, and do not again enter the bay until several days after the storm has subsided.
>
> During the rainy season a large amount of fresh water constantly flows into the bay, carrying with it mud and other material, which to a marked degree seems to

have a deleterious effect upon the food fishes, and it frequently happens that two and three weeks will elapse ere fish will again be found in paying quantities.

The day I arrived at Monterey the fishermen had just finished taking up their nets, and they did not put them down again while I was there, but occupied their time in mending and generally overhauling all their fishing gear.

In summer, when the most valuable species are abundant, and when the weather favors their pursuit, the local fishing grounds are utilized to their full extent; but in winter only a small amount of fishing is done, chiefly in the sheltered coves and about the rocky ledges along the shores of Monterey and Carmel Bays. An important trawling ground frequented by the Chinese is near the shore from Point Alones around to Point Cypress. But "all is fish" that comes to these thrifty and industrious gleaners of marine products, and the shores as well as the sea bottom furnish a field for their enterprise. At low tide the coves and uncovered ledges are searched for sea moss, abalone, sea-urchins, or any other products for which a market can be found.

Fishermen.—The fishermen of this county are wholly natives of southern Europe and China, more than half of them being Chinese. The Europeans are chiefly Portuguese and Italians, and a considerable percentage of these have become naturalized citizens of the United States. The Chinese, however, appear to have no desire for citizenship. They live, as a rule, in miserable squalor, in rude board shanties, but nevertheless seem content, and are satisfied with conditions that would be unbearable to white men, particularly those of American birth. The whites work on shares—one share going to the boat. They make a good living and appear thrifty and contented.

Boats.—The boats used by the white men are built in San Francisco, and are less than 5 tons burden; 4 of the largest are feluccas, and 17 carry sprit-sails. The average crew is two persons, but often only one man goes in a boat, while the larger craft usually carry three. There are also 7 rowboats, worth $25 each. The Chinese at Carmel Bay employ a junk of 11 or 12 tons, and 22 skiffs, or sampans, with an average length of about 21 feet.

Apparatus, methods of fishing, etc.—The white fishermen use drag seines, gill nets, and hand lines. Drift nets and set nets are chiefly used in summer, but to a less extent in winter, when hand lines are in most favor. Trawl lines are prohibited.

Alexander says:

The Chinese pay but little attention to any of the established rules, but persistently fish with trawls and all other gear known to the race; and in consequence of this constant violation of fishing laws there exists a very bitter feeling between the two classes, and frequently severe altercations take place. Notwithstanding complaints are continually being made, no person of influence has ever interested himself enough to try to rectify the wrongs or alleviate the sufferings of the injured class.

The trawl lines used by the Chinese in Monterey and Carmel Bay are rigged with 200 small hooks on each section of ground line, which is coiled in a basket. Each boat carries eight baskets of trawl.

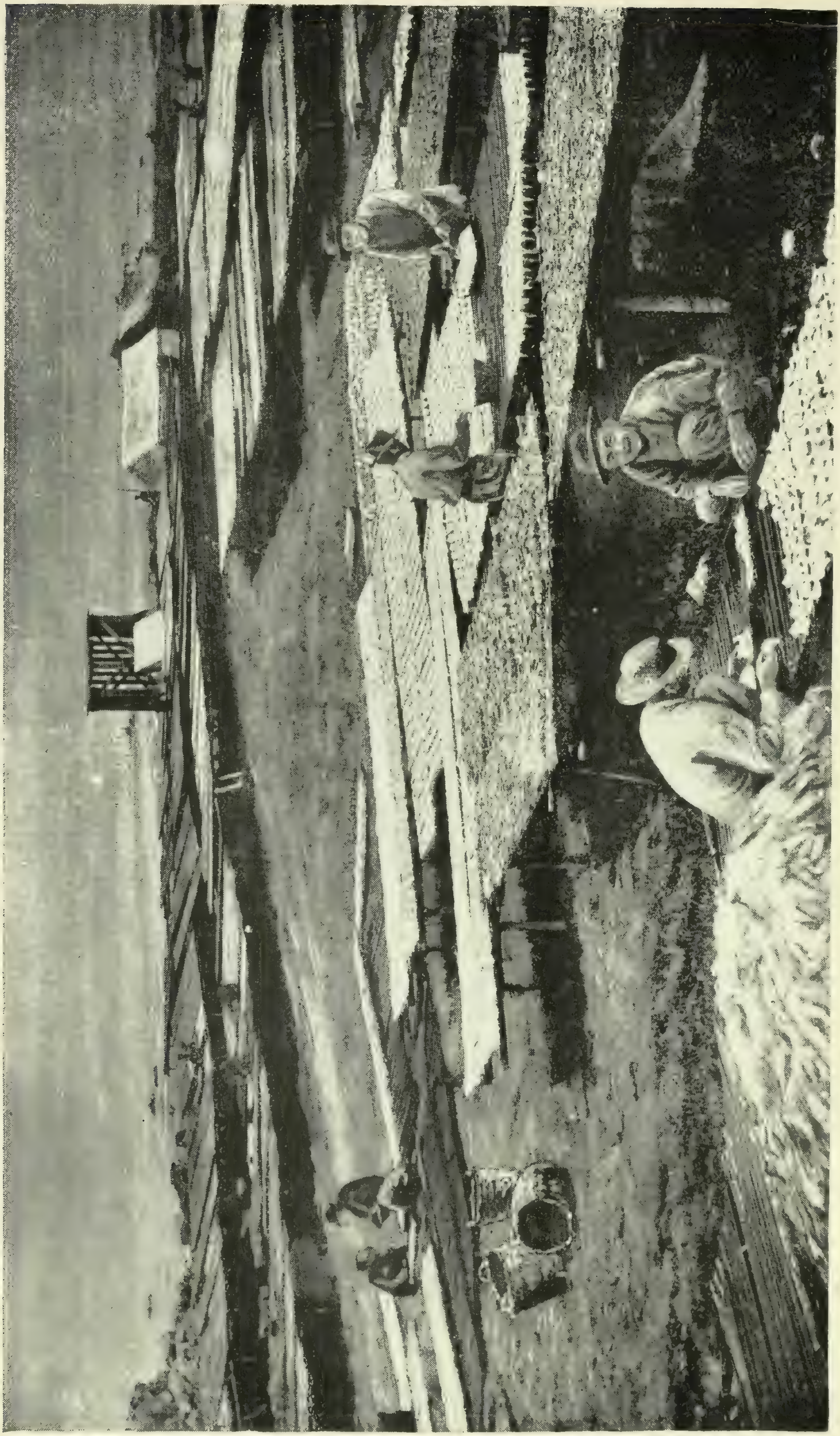
The apparatus and methods employed in the squid fishery are the same in both bays. The fishery is prosecuted at night. Small purse seines are used. These are each 180 feet long, 18 feet deep, with from ½ to 1 inch mesh. A boat with a blazing torch at the bow first starts out and rows slowly around the bay. The object of this maneuver is to attract a large school of squid to the surface, where they can be more easily and surely captured. In company with the boat carrying the torch are two other skiffs, with the seine, their crews eagerly and anxiously watching for the signal that announces a school of squid has been "raised" and are hovering just beneath the surface, in the glow of the light that flares and sparkles in the wind. Instantly, when the signal is given, the seine is thrown out, the fishermen guiding their craft so that the net makes a complete circle around the boat with the light. The seine is quickly pursed up, and its contents are taken into the boats, which return to the shore and land their catch.

The shore whale fishery has been abandoned for several years; the New Bedford fleet having recently resorted to San Francisco to refit, etc., and there having also been a considerable increase in the numbers of whalers from the latter port, the fishermen formerly engaged in shore whaling find it more profitable to go on the vessels, hence the closing of the stations they formerly operated. The station at Carmel Bay remains as it was left, with boats and other fixtures under cover; it is probable that the fishery may be resumed at this station if the price of oil advances and other conditions promise lucrative returns.

Preparation and disposition of products, etc.—The entire catch of the white fishermen and a portion of the products obtained by the Chinese are sold in a fresh condition. Most of the products go to San Francisco, expressed by rail; a comparatively small amount is disposed of locally. No ice is used for their preservation, and, as is generally the case on this coast, the fish are not eviscerated before being sent to market. Here, however, the fishermen have the advantage of living in close proximity to the fishing grounds, and this, together with the facilities for transportation afforded by the railroad, makes it possible for them to put their fish on the market in as good condition as practicable where ice or other means of refrigeration are not utilized.

The Chinese cure quantities of small fish (among which are rockfish, flounders, and perch) that are not sent to market in a fresh state. These are dried round, just as they come from the water; not the least attention is paid to cleanliness. Samples of these seen by the writer had a repulsive odor, and their appearance was anything but attractive as an article of food. Nevertheless, they are in demand in China, where they meet with a ready sale, and are also eaten by the Chinese in the United States.

Squid are cured in a somewhat similar manner. No salt is used on them. The largest specimens are split, washed, and spread on flakes to dry. It requires about two days of fine weather to dry them properly, and they are carefully watched over by those who attend to this work.



CURING SQUID AT POINT ALONES, MONTEREY.

The small squid are not split or cleaned, but are simply spread out to dry in the same condition that they came from the water.

The Chinese have a large flake yard at Point Alones, devoted chiefly to curing squid. Some of the flakes are placed on the ground, but the majority are elevated on posts 2 or 3 feet high, and resemble the codfish flakes in small fishing towns in New England. Here, in the height of the squid season, may be witnessed a busy scene. The squid are brought from the boats in baskets or whatever other receptacles may be convenient. Here and there are groups of Chinese or single individuals, squatting upon the ground or bending over the elevated flakes, every one actively engaged in spreading the green squid or gathering up those already cured (see plate IV). When dried the squid are packed in bundles and covered with matting, each package containing about 135 pounds and upwards. They are sent by steamer to San Francisco, where some are sold to the domestic trade and the remainder exported to the Sandwich Islands and China.

The products of the abalone fishery are treated in the ordinary manner, the "meats" being dried and the shells prepared for shipment or local sale. Some of the Chinese find employment in gathering and selling to tourists, in addition to abalone shells, all sorts of "sea trinkets," among which sea-urchins and various small shells figure conspicuously.

Sea moss is dried and packed in sacks holding about 147 pounds.

The following tabulated statement, obtained from official records, through the politeness of the transportation companies, shows in detail the monthly shipments of fishery products at Monterey. All such material, except abalone shells and sea moss, is classified under the general term of fish; but as fresh products are shipped by express over the railroad, and all others go by the less expensive steamer route, it is easy enough to separate the fresh fish from the cured.

Monthly shipments of dry and fresh fish from Monterey to San Francisco in 1888.

Month.	Cured fish by steamer.		Fresh fish by railroad.	
	Packages.	Pounds.	Packages.	Pounds.
January	21	2,830	386	50,121
February	9	1,100	241	30,171
March	6	460	618	81,948
April	8	1,400	673	88,840
May	187	25,255	831	110,559
June	769	121,852	622	83,360
July	83	10,215	682	89,508
August	256	31,385	1,207	172,717
September	468	67,090	815	106,401
October	46	5,075	1,088	150,346
November	58	15,595	627	87,950
December	104	15,920	571	78,430
Total	2,015	*298,177	8,361	†1,130,351

* Including the weight of 2,015 packing boxes; net weight, 281,147 pounds. In addition to these quantities of fish, 11 sacks of abalone shells, weighing 855 pounds, and 60 sacks of sea moss, weighing 8,820 pounds, were also shipped by steamer.

† Including 209,025 pounds, the weight of 8,361 packing boxes, the net weight of the fish being 921,326 pounds.

The extent of the fisheries in 1888 is shown in the following tables:

Persons employed.

Country.	Nationality.	Nativity.
United States	35	
Portugal	5	30
Italy	7	17
Spain	4	4
Austria	2	2
China	74	74
Total	127	127

Apparatus and capital.

Designation.	Number.	Value.
Junk (11 tons)	1	*$900
Sailboats, lateen-rigged	4	3,000
Sailboats, sprit-rigged	17	1,400
Small rowboats	7	175
Chinese boats	22	4,400
Purse seines	14	3,500
Drag and sweep seines	6	465
Gill nets	80	2,400
Lines (including trawls, with 61,000 hooks)		533
Shore property		500
Total		17,273

* Including outfit.

Products and values.

Species.	Pounds.	Value.
Fresh salmon	5,000	$250
Other fresh fish	946,326	47,316
Dried fish and squid	281,147	14,057
Abalone shells	10,855	515
Total	1,243,328	62,138

19. FISHERIES OF SANTA CRUZ COUNTY.

Geographical features.—The general trend of the seacoast of this county is northwesterly. The shore line is, however, in the form of a reflex curve, its southern end bordering the northern side of Monterey Bay, curving away nearly west to Santa Cruz, where it turns northward. Its length, following the curvature of the coast, is about 40 miles. In some places the shores are low, and the beaches are generally sandy or shaly. Jordan says that "running parallel with and north of the beach are bluffs of considerable height; these in some places are extended as ledges or reefs under the sea." The cliffs facing the sea are in many places wave-worn and vertical or nearly so, offering no shelter or landing-place for even the smallest fishing boat.

Fishing centers.—The fishing centers are Santa Cruz and Soquel. Both towns are within easy reach of San Francisco by rail or steamer. The former is a pleasantly situated seaside resort of some note, located on the north side of Monterey Bay, and having in 1888 an estimated population of about 6,000. Its harbor is not good, being open to southerly and westerly storms, and when the wind blows hard from those directions it is impracticable for boats to go out.

The fishing interests of Santa Cruz are controlled by two firms, who own two long piers, which serve the double purpose of fishing stations and steamer landings. In summer the boats usually lay at anchor off the town, when not engaged in fishing, but in fall and winter the weather is more boisterous, and they are always hoisted, at the close of each day's work, to large wooden davits fastened to the sides of the wharves, like the davits on the side of a whale ship. During the prevalence of gales on the coast the sea is so heavy that boats lying at anchor off the town would either founder or drive ashore and be destroyed. It is therefore manifestly necessary to either hoist them in this manner or run them up on the beach out of the way of danger. Wilcox states that both methods are in vogue. One of the Santa Cruz firms—locally called companies—owns 15 boats, and the other has 3. These constitute the entire fleet from this place, since the fishermen own no boats.

Soquel is a small village about 5 miles east of Santa Cruz, on the line of the railroad, near the mouth of Soquel Creek. It has a somewhat better shelter for boats than Santa Cruz, and is therefore a favorite shipping point to San Francisco. It has a fleet of 10 small fishing boats.

In 1878 Aptos, a railroad station 3 or 4 miles east of Soquel, was a fishing center of some note, according to Professor Jordan, who states that "at a point between Soquel and Aptos are about 50 fishermen." In the year mentioned 80,818 pounds of fish were caught at Aptos.* At the present time there is no fishing from Aptos.

Importance of fisheries.—The fisheries of Santa Cruz County are at present unimportant. In 1888 the number of men employed was less than half the number reported for 1878 by Professor Jordan. The products remain essentially the same, however, being 233,831 pounds, net, in 1878, and 235,247 pounds, worth $11,762, in 1888. This would indicate that the men now engaged in fishing give more exclusive attention to it than formerly.

Species, seasons, etc.—For the most part the marine species here are essentially the same as those in the waters of Monterey County. There is, however, an entire absence of abalone and sea moss. Shad and salmon are much more numerous here, and species of fresh-water fish occur that are not found at Monterey or are less plentiful. Shad have annually made their appearance in Monterey Bay for several years past, and occasionally have been quite numerous. They generally

* "The Fisheries and Fishery Industries of the United States," page 605.

arrive in the spring, but there are exceptions to this rule, according to the local fishermen. The season is from March till June. The bulk of the catch is between April 15 and May 15, but occasionally a few are taken as late as October. During 1887 shad were exceptionally abundant, one or two tons being shipped a day. In 1888 the catch was much smaller and not above the average. Salmon occur from March to May, both in the bay and in San Lorenzo Creek, which empties into the harbor of Santa Cruz; they range from 8 to 20 pounds.

Salmon trout, weighing from 5 to 12 pounds, are plentiful in the creek at times during the spring. Brook trout were formerly abundant, but have become scarce from excessive fishing; those remaining weigh from less than a pound to upwards of 4 pounds.

Fishing grounds.—The grounds are near the shore and along the reefs for 10 or 15 miles each side of Santa Cruz. They are much exposed to the south and west, and when the wind blows strong from those quarters the fishing boats can not venture out, for the sea breaks heavily along the coast.

Fishermen, lay, etc.—The fishermen are mostly native Californians. The rest are Portuguese and Italians, all of whom are naturalized citizens of the United States. There is much difference in the economic condition of the fishermen. Those at Soquel own their boats and fishing gear, and share the catch among themselves. At Santa Cruz, however, the boats and all the apparatus are owned by firms, and the fishermen work on a lay. The owners of the boats and outfit receive one-third of the fish taken; the fishermen have two-thirds. Mr. Alexander remarks that "this seems to be a generous lay; but the owners have the privilege of establishing the price of fish at all times." This privilege, he thinks, may account for their seeming liberality. The earnings of the fishermen vary from $18 to $20 per week in summer to $8 or $10 (and sometimes much less) in winter. In the winter of 1889–90 fish were exceptionally scarce and the income of the fishermen was correspondingly small.

Boats.—Most of the boats employed here are feluccas; a few of the smaller class are sprit-rigged. Alexander states that "in size, rig, and general construction they are the same as those of San Francisco." He also mentions the fact that two lateen-rigged boats, each 25 feet long, are employed in summer in fishing with a paranzella.

In the early part of 1889 Wilcox found only 12 fishing boats at Santa Cruz, but the next winter, when it was visited by Alexander, the number had increased to 18.

Apparatus and methods of fishing.—Trawl lines are set along the coast for bottom-feeding species. Hand lines are not extensively used. Gill nets and trammel nets are employed for the capture of several important species, among which may be specially mentioned sea bass, barracuda, salmon, and shad. The sea-bass gill nets are each 120 feet long and 40 meshes deep, the mesh being 8½ inches stretch measure. These nets

are made by the fishermen, who obtain their twine principally from Boston, Massachusetts, but some of it is imported from Italy. The imported twine costs 85 cents per pound, the domestic 60 cents. The gill nets used for barracuda fishing are similar to those previously described. They are bought by the fishermen at an average price of 60 cents per pound, including the hanging ropes and corks.

Salmon and shad are also caught in gill nets in Monterey Bay, but Alexander says that the fishermen of Monterey Bay have no gill nets specially designed for catching shad, and fish of this species that are gilled "are taken in nets with a mesh much smaller than the law requires." But the shad are usually found dead after remaining in a gill net for several hours, and the fishermen naturally object to throwing their catch back into the sea to rot or to be devoured by predaceous fish; therefore the shad are taken to market or are otherwise utilized.

The paranzella is employed here in summer, chiefly for the capture of flounders, though red rockfish, crabs, etc., are frequently taken in it. The names "bag seine," "drag seine," and "bag net" are usually applied to the paranzella on the Pacific coast by those unfamiliar with its origin and its European designation. The paranzella consists of a deep, cone-shaped bag of fine-meshed netting, flanked by long narrow wings, the upper edges of which (as well as the bunt) are supported by cork floats, while the lower edges are weighted with lead sinkers so that they will sweep the bottom like the foot line of a beam trawl. It is usually hung so that the net sweeps back in a deep curve between the foot line and the cork rope. The average size of the paranzella used at Santa Cruz is 85 feet long, from end to end of the wings. The bag or bunt is 30 feet in length. When in operation, the cork rope is 6 feet above the foot line, but, measuring the curve of the twine, they are separated 20 feet. There is a 4-inch mesh in the wings and a 2½-inch mesh in the bag. This type of net is used as a drag seine, being hauled on shore, and it is also operated in comparatively deep water some distance from the coast.

Two boats are required for fishing with a paranzella in deep water. A long, stout rope extends from the quarter of each boat to one wing of the net, and they sail along, widely separated but parallel with each other, slowly dragging the apparatus over the bottom. When the end of the ground is reached, or for other reasons the net has been towed long enough, it is hauled in and its contents taken into the boats.

Spears are used to some extent for catching salmon in San Lorenzo Creek. The spears have three barbed prongs, 6 or 7 inches long and 2 inches apart. There is a deep socket above the spearhead and into this is fitted a pole 8 or 10 feet long. A strong line is fastened to the spearhead and passed through rings on the shaft to the hands of the fisherman. When a fish is struck, the spear is detached from the handle and the salmon is pulled in by the line.

Preparation, transportation, markets, etc.—The fishery products of this county are marketed fresh, and are not preserved or in any manner

prepared for market. The larger part of the catch goes to San Francisco, but considerable quantities are disposed of in the interior towns along the line of the railroad. Soquel is the favorite shipping point, 138,068 pounds of fish having been sent from there by express in 1888, against 22,179 pounds from Santa Cruz. The local demand at the latter place is considerable in the summer season, and sufficient to utilize most of the fish landed at that point. In 1888 75,000 pounds were disposed of there.

The business of supplying Santa Cruz with fish is controlled by the owners of the fishing boats. Peddlers are sent out to hawk the fish about town, but the contents of their coverless wagons (exposed to the sun, dust, and flies) soon become unattractive, if not repulsive. Fish carts also go to San José and a few suburban towns. A well-conducted fish market is much needed at Santa Cruz. The retail price of fish averages about 6 cents in summer and 10 cents in winter. There is considerable complaint of the high price of fish among the residents of Santa Cruz and contiguous places, but the profits derived from fishing have not yet been sufficient to induce much competition.

Following is a tabulated statement showing the monthly shipments of fish from Santa Cruz and Soquel, as obtained from the records of the Wells, Fargo & Co. Express, which transports all products of this kind sent by rail.

Monthly shipments of fresh fish from Santa Cruz and Soquel during 1888.*

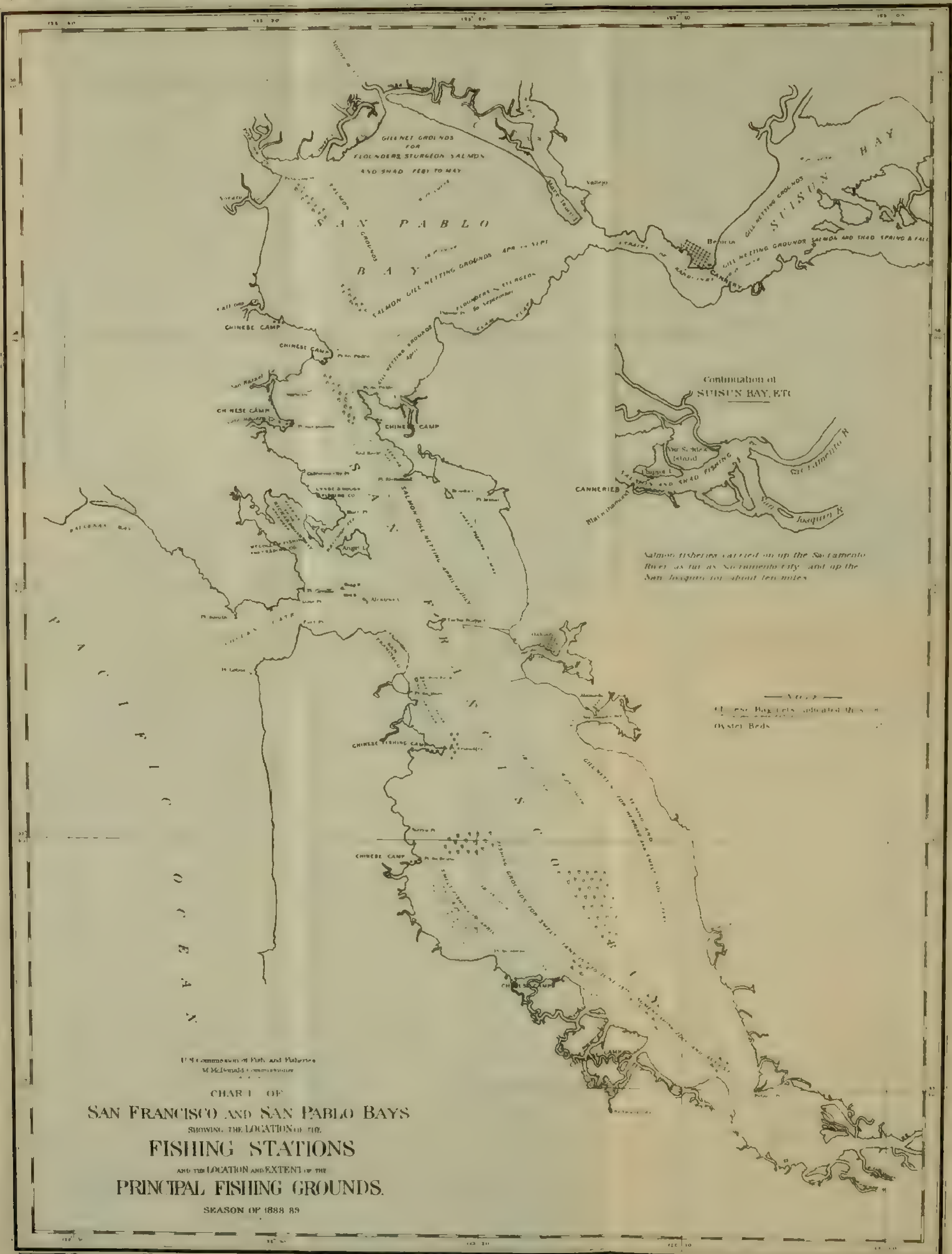
Month.	Santa Cruz.	Soquel.
	Lbs.	*Lbs.*
January	1,089	1,440
February	1,196	....
March	1,733	670
April	2,027	5,230
May	2,416	18,335
June	558	11,260
July	1,339	15,433
August	4,179	33,360
September	5,500	48,070
October	3,709	8,240
November	1,069	7,455
December	364	6,970
Total	†25,179	‡156,463

* Nearly all shipped to San Francisco; a small amount was sent to towns on the railroad.
† Includes 3,020 pounds for weight of 208 boxes; weight of fish was 22,179.
‡ Includes 18,395 pounds for weight of 1,293 boxes; net weight of fish, 138,068 pounds.

The statistics of the fisheries of this county are shown in the following tabulated statements:

Persons employed.

Country.	Nativity.	Nationality.
United States	15	25
Portugal	7	....
Italy	3	....
Total	25	25


GILL NET GROUNDS FOR FLOUNDERS STURGEON SALMON AND SHAD FEBY TO MAY
SAN PABLO BAY
SALMON GILL NETTING GROUNDS APR TO SEPT
SUISUN BAY
GILL NETTING GROUNDS SALMON AND SHAD SPRING & FALL
Vallejo
Benicia
CHINESE CAMP
San Rafael
CHINESE FISHING CAMP
CANNERIES
Continuation of SUISUN BAY, ETC
SALMON AND SHAD FISHING
Sacramento R
San Joaquin R
Salmon fisheries carried on up the Sacramento River as far as Sacramento City and up the San Joaquin for about ten miles
SALMON GILL NETTING APRIL TO JULY
Oyster Beds
PACIFIC OCEAN
U S Commission of Fish and Fisheries
M McDonald Commissioner
CHART OF
SAN FRANCISCO AND SAN PABLO BAYS
SHOWING THE LOCATION OF THE
FISHING STATIONS
AND THE LOCATION AND EXTENT OF THE
PRINCIPAL FISHING GROUNDS.
SEASON OF 1888 89

Apparatus and capital.

Designation.	Number.	Value.
Boats	20	$10,900
Gill nets	110	4,400
Bag nets	6	750
Trawl lines, spears, etc		910
Shore property		450
Total		17,410

Products and values.

Species.	Pounds.	Value.
Salmon, fresh	15,000	$750
Shad, fresh	20,000	1,400
Other fresh fish	200,247	9,612
Total	235,247	11,762

20. FISHERIES OF SAN FRANCISCO, SAN PABLO, AND SUISUN BAYS, WITH ADJACENT SEACOAST, INCLUDING THE COUNTIES OF SAN MATEO, SAN FRANCISCO, SANTA CLARA, ALAMEDA, CONTRA COSTA, SOLANO, SONOMA, AND MARIN.

General considerations.—The fisheries of this entire region are so intimately associated with and form so large a part of the fishing business of the city of San Francisco that no other method seems expedient than to discuss the interests of all these counties under one head. In many cases firms with headquarters and business houses at San Francisco have curing establishments at some point on the bay in another county, while the same is true concerning oyster-dealers, who trade in the city and have their oyster beds located 10, 15, or 20 miles distant. In many other ways there is an inextricable commingling of interests, but lack of space prevents the presentation of detailed statements relating to this matter.

The salmon fishery on San Pablo and Suisun Bays that is tributary to the canneries in the vicinity will not be considered under this head, but will be discussed in connection with the fisheries of the Sacramento and San Joaquin Rivers.

Geographical characteristics.—The geographical features of this section are extremely varied, but on the whole are particularly favorable to the prosecution and development of the fisheries. Mountainous shores, bold headlands, and steep cliffs alternate with low, flat stretches of coast fringed by sandy beaches or areas of mud flats. The seacoast south of the Golden Gate has a general trend nearly north and south. It is high and bold, and, with few exceptions, there are no indentations that afford even temporary shelter for fishing boats. For this reason the coast is dangerous when strong gales occur in winter. At Point Año Nuevo boats sometimes find shelter; Half-moon Bay, south of Pillar

Point (17 or 18 miles south of the Golden Gate), affords anchorage in northerly or easterly breezes; and about 6 miles farther north, under Point San Pedro, boats may ride in southerly or easterly winds. However, this is only about 10 miles from Point Lobos, and with such winds boats can soon run up to San Francisco.

North of the Golden Gate the coast of Marin County extends west-northwesterly to Point Reyes, where it turns abruptly northward, its general course thence being nearly north to its junction with Sonoma County, which stretches away to the northwest, its shores unbroken by any important bays or harbors. From a fishery standpoint Sonoma County is chiefly noteworthy for Russian River, a salmon stream of some importance. In Marin County, Drake's Bay affords excellent shelter in most winds and is a noted fishing ground at all seasons. Bodega Bay, west and south of Bodega Head, is connected with Tomales Bay, which extends inland in a southeasterly direction about 17 miles, and has a width varying from about one-third of a mile to upwards of a mile. It is one of the best fishing localities along the seacoast of the State.

Entering the Golden Gate we come upon the broad, well-sheltered waters of San Francisco Bay, stretching from Santa Clara County on the south, in a north-northwesterly direction, to Point San Pablo and Point San Pedro, a distance of about 38 miles, its width varying from 1 to 11 miles. Its shores are much diversified by hills and flat marshes, irregular in outline, with many coves, small bays, projecting points, and islands. Here, on the west side of the bay, opposite Oakland and Yerba Buena Island, and near the Golden Gate, is the important city of San Francisco, and at other points are situated fishery centers, curing stations, etc., that will be more specifically mentioned in subsequent pages. Over a very considerable part of the bay, and particularly on the east side, the water is shallow, being less than 18 feet, while a large area has a depth of only 6 feet or less.

Passing through the narrows between Point San Pedro and Point San Pablo, we enter San Pablo Bay, a broad, shallow, nearly pear-shaped estuary, with rather irregular shores. Its greatest diameter is a little more than 11 miles, and its average width is approximately 7 miles. Several streams flow into it, among which may be mentioned Napa Creek, Sonoma Creek, Petaluma Creek, Novato Creek, and Gallines Creek. It is connected with Suisun Bay on the east by the Strait of Carquinez, which is nearly 4 miles long, with a good depth of water. Suisun Bay is small and shallow, with the exception of the channels resulting from the inflow of the Sacramento and San Joaquin Rivers, and other minor streams that enter it on the north and east. Its extreme length is about 10 miles; it is about half as wide, but in the east end and middle of the bay are many islands, several of them of large extent, that restrict the water area materially.

Importance of the fisheries.—The marine fisheries of this region, particularly those which center at San Francisco, are very important, and

probably exceed in magnitude the combined value of all other similar fisheries along the entire coast of the Pacific States from San Diego to Puget Sound, including those localities. In addition to the local or shore fishery prosecuted from boats, etc., and which of itself is a large industry, San Francisco is extensively interested in the pursuit of the cod, whale, and fur-seal fisheries, which employ large numbers of men and much capital, while the products reach an aggregate value of considerable magnitude. The river or fresh-water fishery is of secondary importance, and, though not insignificant, it can not be favorably compared with the immense operations on the Columbia River, or even with those prosecuted on streams of less consequence. Nevertheless, considerable quantities of anadromous species, and notably the salmon, are taken in the bays, when the fish are en route to their breeding-grounds. As a whole, San Francisco and vicinity may be considered one of the leading fishery centers of the United States, and its possibilities of development in this particular are believed to be very great.

Because of their magnitude the fisheries of this region will be considered separately.

Fishing centers.—The city of San Francisco is the great fishing center of this region and as a market and point of distribution maintains fisheries at other points in its vicinity. The varied character and importance of its fisheries will appear in the detailed discussions that follow; there also will be found extended reference to the fleets of vessels and boats that sail from this port, or bring hither their products for sale or shipment. The New England whalers that hunt their prey in the icy Arctic Ocean north of Bering Strait come to San Francisco in fall and winter to land their catch and refit for other cruises.

The fisheries of San Francisco have built up in the city several manufacturing enterprises, while the disposal of fishery products employs a considerable amount of capital and many people. Four firms are engaged in the manufacture and sale of fishing apparatus, and, in addition to supplying the local demand, they ship goods to other points along the coast from Panama to British Columbia, while occasional invoices are sent to the Pacific Islands. It is estimated that fully 40,000 pounds of cotton rope and "hanging twine" of American manufacture are annually sold to the fishermen and canneries of British Columbia, while some 36,000 pounds of trap netting, valued at about $15,000, are exported to Panama and one or two of the Pacific Islands.

The importance of San Francisco as a fishing and distributing center is best shown, perhaps, by a consideration of exports and imports of fishery products. In 1888 the exports of cured cod, canned, salt, and smoked salmon, other species of canned or cured fish, crustaceans, and shellfish amounted to $2,711,377. The exports of whale and fish oils for the same year, according to the custom-house records, aggregated $64,634. In 1886 the collector of the port, Hon. John S. Hager, reported the imports of "all other dutiable fish, $66,665." These fish came chiefly from China, and were for the Chinese trade of California.

The following tables show in detail the export trade of the city:

Exports of fishery products from San Francisco during the year 1888.

Countries to which exported.	Codfish, cured.		Other cured fish.		Canned salmon.		Pickled and smoked salmon.	Other canned fish.	Oysters.	Other shellfish and crustaceans.*	Total value of exports.
	Lbs.	*Dolls.*	*Lbs.*	*Dolls.*	*Lbs.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Great Britain	......	......	......	......	18,054,804	2,054,353	......	......	......	......	2,054,353
Australia	407,910	26,511	12,000	516	2,046,328	240,413	11,283	......	44	3,265	282,032
British Columbia	9,390	607	8,700	470	......	......	50	187	5,997	1,534	8,845
British East Indies	17,250	1,127	7,000	390	24,690	3,035	......	314	......	85	4,951
French possessions	9,800	571	1,000	56	35,498	3,893	1,798	372	238	447	7,375
Germany	......	......	......	......	......	......	......	......	......	100	100
China	48,450	2,851	297,010	16,878	121,394	14,748	......	296	176	164,800	199,749
Japan	7,600	455	26,380	1,897	21,395	2,588	......	195	83	739	5,457
Russia	......	......	......	......	......	......	......	......	......	24	24
Mexico	12,015	722	......	......	27,875	3,028	......	1,627	1,034	360	6,771
Costa Rica	2,500	146	......	......	23,350	2,561	......	845	128	108	3,788
Ecuador	......	......	......	......	......	......	......	66	85	......	151
Guatemala	17,830	1,163	......	......	4,440	512	86	260	212	169	2,402
Honduras	......	......	......	......	......	......	......	108	22	......	130
Nicaragua	240	16	......	......	1,456	172	......	323	184	......	695
San Salvador	1,300	78	......	......	2,075	233	......	188	325	130	954
U. S. of Colombia	......	......	......	......	57,820	6,479	177	77	......	1,606	8,339
Chili	......	......	......	......	......	......	......	......	......	7,771	7,771
Hawaiian Islands	264,150	13,848	506,737	27,195	163,841	15,189	23,765	2,307	6,167	20,372	108,843
Other islands and ports	1,000	57	......	......	40,290	5,014	2,934	267	193	182	8,647
Total	799,435	48,152	858,827	46,902	20,625,256	2,352,218	40,093	7,432	14,888	201,692	2,711,377

* These consisted mostly of abalone and shrimp, the largest part being shrimp exported by the Chinese to Hongkong and the Sandwich Islands. Squid is included under "other cured fish," it being impossible to secure separate figures for that mollusk from the custom-house records.

Exports of whale and fish oil from San Francisco during 1888.

Whither sent.	Sperm oil.		Whale and fish oil.	
	Galls.	*Dolls.*	*Galls.*	*Dolls.*
Australia	......	......	44,510	12,370
England	......	......	71,405	12,569
France	......	......	147,237	33,128
Hongkong	......	......	17,067	4,876
Hawaiian Islands	560	369	1,061	312
Mexico	......	......	5,302	1,280
Philippine Islands	......	......	496	99
Total	560	369	287,078	64,634

Monthly exports of fishery products from San Francisco, exclusive of salmon, in 1889.

Month.	Codfish.		Minor species of fish, squid, etc.		Value of oysters.	Value of abalones and shrimp.	Total value of exports.
	Pounds.	Value.	Pounds.	Value.			
January	72,042	$4,292	59,700	$3,223	$1,990	$13,282	$22,787
February	95,880	6,050	40,200	2,005	1,116	28,398	37,569
March	113,840	7,144	28,300	1,522	1,207	19,368	29,241
April	59,790	3,516	15,050	778	1,105	13,682	19,081
May	66,260	4,046	44,115	2,627	1,757	19,508	27,938
June	37,790	2,080	246,250	14,367	1,380	41,276	59,103
July	39,460	2,100	46,800	2,586	1,615	18,057	24,358
August	52,720	3,201	142,400	9,023	2,139	37,914	52,277
September	54,935	3,491	42,600	2,382	1,489	17,203	24,565
October	57,690	3,545	83,150	4,665	2,217	20,183	30,610
November	58,840	3,860	37,750	2,070	1,883	11,391	19,204
December	60,470	3,620	28,550	1,563	2,129	8,689	16,001
Total	769,717	46,945	814,865	46,811	20,027	248,951	362,734

The exports of canned salmon amounted to 479,123 cases, valued at about $2,635,200.

The products mentioned in the first table under the caption of "other cured fish" (amounting to $46,902) are composed chiefly of salted and dried bonito and barracuda, which, prepared in this way, are dark-colored like ordinary smoked fish, and have a rather strong odor. They are mostly shipped to the Hawaiian Islands, and are also in favor among Italians, Portuguese, and Chinese. "Shellfish and crustaceans" are mostly shrimp and dried abalone, which go largely to China. A considerable portion is the product of the junk fishery, and includes dried oysters obtained on the coast of Lower California or Mexico.

There is considerable "shore property" at San Francisco utilized in connection with the fisheries. The wharves, storehouses, etc., used for the market fishery will be mentioned in discussing that industry.

There are no important fishing centers in this region south or east of San Francicso; a Chinese fishing camp is, however, located at Point Avisadero, San Francisco County. On the southwest side of the bay, in San Mateo County, are three other Chinese camps; one is at Point San Bruno, 8 or 9 miles south of San Francisco; another is about 8 miles farther off, nearly 3 miles southeast of Point San Mateo; the third is located near the mouth of Redwood City Creek. There are no fishing stations of special importance on the seacoast of San Mateo County, nor has Santa Clara County any fishery, though it borders the extreme south end of San Francisco Bay.

The fishing grounds near the shores of Alameda County are frequented by boats from other sections of San Francisco Bay, but there is no point in the county from which any commercial fishery is prosecuted. Indeed, profitable fishing is impracticable, for the shore at low tide is mostly a wide stretch of uncovered mud flats with no suitable landing for fishing boats.

A fine quality of salt used in the fisheries is made by natural evaporation from water brought to the salt marshes of the county from San Francisco Bay. It is preferred to any imported salt and exclusively used for fish-curing purposes. Packed in bags holding about 120 pounds each, it sells for from $7.50 to $8.50 per ton.*

There is a Chinese fishing camp about 2 miles south of Point San Pablo, in Contra Costa County. Aside from this there are no fishing stations in this or Solano County, except those devoted chiefly to the salmon fishery at Black Diamond, Benicia, and Chipp's Island, which will be considered in connection with the fisheries of the Sacramento and San Joaquin Rivers.

Sonoma County has no important fisheries except those of Russian River.

---

*An analysis made by W. T. Wenzell & Co., of San Francisco, showed this salt to consist of the following constituents: Chloride of sodium (pure salt), 99.063; carbonate of soda, .011; sulphate of soda, .012; chloride of calcium, .052; sulphate of magnesia, traces; oxide of iron, .002; water, .860.

In Marin County, on San Francisco and Richardson's Bays, are the important curing stations of California City and Pescada Landing; and north of the former, at Point San Quentin, Point San Pedro, and 2 or 3 miles northwesterly from the latter, are Chinese fishing camps. On the seacoast the chief fishing centers are Fisherman's, Marshall, Hamlet, Tomales, and Point Reyes, on or near Tomales or Bodega Bays and on the line of the North Pacific Coast Railroad. Sausalito, the southern terminus of this road and just across the Golden Gate from San Francisco, is an unimportant fishing point.

Fishing grounds.—The fishing grounds resorted to by the fishermen of San Francisco and vicinity cover an immense area, and are as varied in character and geographical location as the fisheries prosecuted upon them. They will be alluded to here only in a general way, as the limits of this review preclude extensive details.

Pelagic fur-sealing is prosecuted in the open ocean off the coasts of the Pacific States (at varying distances from the land, but generally not exceeding 150 miles), thence along the coasts of British Columbia and Alaska. Seals are also followed into Bering Sea; but this ground can not be legally resorted to for pelagic sealing. The Pribilof Islands (St. Paul and St. George) have for many years been the most important ground in the world for the capture of fur seals. The right to take seals here (100,000 skins per year) has been controlled by the Alaska Commercial Company, of San Francisco, under a 20-year lease (expiring in 1889) from the United States Government.

There is no systematic fishery for hair seals, sea lions, or walrus, but these are occasionally taken by fishermen sailing from San Francisco or by natives who hunt or fish in Alaskan waters for the large firms having their headquarters in this city. Since the capture of these animals is a mere incident of fishery, so far as this locality is concerned, and as a discussion of the northern grounds frequented by them belongs more properly to a consideration of the Alaskan fisheries, it only seems necessary here to mention the fact that the Farrallone Islands, off the mouth of the Golden Gate, and about 23 to 27 miles distant, seaward, are noted for having extensive rookeries of sea lions (*Zalophus californianus* and *Eumetopias stelleri*), among which the southern species (*Z. californianus*) largely predominates.

The sea-otter fishery, which is practically under the exclusive control of capitalists in San Francisco, is carried on about the islands, ledges, and in the waters of Alaska.

Bering Sea and the Arctic Ocean north of Bering Strait are chiefly resorted to by the whalemen, though whales are also taken on some of the Pacific grounds and in the Japan and Okhotsk Seas.

The Japan ground, which embraces the region "from the coast of Japan southeast to the Bonin Islands, across to 165° west longitude," is occasionally resorted to, but the Okhotsk Sea is more commonly visited by whalers and is next in favor to the Arctic Ocean. In the season of

1889 40 of the fleet cruised in Bering Sea and the Arctic Ocean; the others fished exclusively in the Okhotsk and Japan Seas. Seventy-one whales were taken by the Arctic fleet, and 76 by vessels cruising on the last-mentioned grounds.

The most noted cod-fishing grounds are the banks in the Okhotsk Sea, in Bering Sea, and close inshore about the Shumagin Islands. Recently, in the summers of 1888 and 1889, the U. S. Fish Commission steamer *Albatross* discovered and investigated large areas off the Alaskan coast that are excellent cod-fishing grounds, while others heretofore known to exist have been surveyed and their value determined by extensive research.*

The shore or local fishing grounds of San Francisco and vicinity are extensive and important. The region about the Farrallone Islands is a noteworthy fishing ground, nearly 20 miles long, with an average width of about 6 miles. Over a large part of this area trawl-line fishing is pursued by the San Francisco market boats; the same boats fish along the coast south of the Golden Gate from April to October; their principal ground for trawl-line fishing begins about 6 or 7 miles south of Point Lobos and extends to Pigeon Point, about 30 miles further south. Occasionally a boat goes as far as Monterey Bay. Between Duxbury Point and Bodega Head, along the coast north of the Golden Gate, is a favorite fishing ground for the San Francisco market fleet, as well as for the local fishermen; trawling is pursued here throughout the year. Drake's Bay is a good locality for gill-net fishing for smelt, herring, and perch. Tomales Bay is one of the best fishing grounds on the coast. Russian River, about 15 miles farther north, is a salmon and trout stream of some importance.

Practically the entire area included within the boundaries of San Francisco, San Pablo, and Suisun Bays is fishing ground, upon which many species of fish, crustaceans, mollusks, etc., are taken, and almost an endless variety of apparatus and methods are employed. Over a considerable portion of each of these bays the water is shallow, being within the 6-foot curve; the area between this and the 18-foot curve is comparatively small, while the channel, with a depth exceeding 18 feet, is extensive in dimensions and affords ample opportunity for navigation by vessels of large size as well as a suitable depth for prosecuting certain fisheries. At the south end of San Francisco Bay, and in coves on the west side, 10 to 15 miles south of the city, are important oyster beds, which will be referred to further under the head of the oyster fishery.

The map, plate VI, shows the principal localities for fishing in these bays at different seasons, and with various forms of apparatus. For this reason it is not considered necessary to enter into greater descriptive details.

Vessels and boats.—In 1888 the fleet of fishing vessels sailing from San

* For more extensive details see vol. VIII, Bulletin U. S. Fish Commission, 1888; also notes on cod fishery in this review.

Francisco, including those used as transports in the cod, salmon, and oyster fisheries, numbered 71, with an aggregate net tonnage of 11,820.65; manned by 1,451 men. Of these, 12 vessels, with a tonnage of 630.52, were engaged in pelagic sealing, sea-otter hunting, and the capture of walrus; 28 vessels (of which 8 were steamers), with an aggregate tonnage of 8,278.46, were employed in the whale fishery. In the cod fishery there were 2 barkentines, with a combined tonnage of 623.41 tons, that went to the Okhotsk Sea, and 7 vessels, of 1,075.31 tons, that fished about the Aleutian Islands, in Bering Sea, or acted chiefly as transports. Three sloops, averaging about 13 tons each, and three sailboats transported oysters from the beds in the San Francisco Bay to the city; two were also used for other purposes in connection with the salmon fishery. In addition to the vessels a fleet of 429 boats of less than 5 tons each are employed in the shore fisheries of this region, many of these being feluccas.

THE WHALE FISHERY.

Importance, etc.—The whale fishery prosecuted from San Francisco is now an important industry. Its development in the last decade has been most remarkable, and is in striking contrast to the marked decline of the fishery from New England ports. This clearly illustrates the advantages San Francisco has for controlling the industry, so long as the chief whaling grounds are in the Arctic Ocean, north of Bering Strait, along the northeastern coast of Asia, and in the northern Pacific.

Clark notes that there were only 3 vessels engaged in the North Pacific whale fishery (including the Arctic Ocean) from San Francisco in 1879. Their aggregate tonnage was 1,470. In 1888 the San Francisco whaling fleet numbered 28 vessels, with an aggregate tonnage of 8,278.46 tons, manned by 932 officers and seamen. Of these, 8 were steamers with a tonnage ranging, for each vessel, from 250 to 860 tons; 14 were barks, averaging upwards of 300 tons each; and there were 1 brig and 5 schooners. Of this fleet, 3 barks fished in the Okhotsk and Japan Seas, and all the rest went to the Arctic Ocean. The fleet included two "tenders," the steamer *Jeanie* and the bark *Thomas Pope.* In 1889 there were 26 vessels actually engaged in whaling, exclusive of 2 tenders. Of these there were 7 steam-whalers, 12 barks, 1 brig, and 6 schooners, the whole having a value, with outfit, of nearly $940,000.

It is as true now as in 1880 that "the interest of San Francisco in the whale fishery can not be measured by the number of vessels owned there, for almost the entire North Pacific and Arctic fleets are accustomed to make that place a fitting port and the headquarters for reshipment of oil and bone to the Atlantic seaboard."* The facilities for shipment afforded by the transcontinental railroads have had a marked influence on the industry in San Francisco, and from being a place where

*The Whale Fishery, by A. Howard Clark, in "The Fisheries and Fishery Industries of the United States."

whale ships were only occasionally seen, it has become the greatest whaling rendezvous of the world.

Fishermen, lay, etc.—The crews of the Pacific whalers are exceedingly heterogeneous in their make-up. Representatives of nearly every State and Territory in the Union, of the various European nationalities, of Canada and South America, together with natives of the Pacific Islands, Asia, and Africa, may be found on board the whaling vessels. Together they constitute perhaps the most cosmopolitan assemblage to be found in a single industry anywhere on the globe.

Nationality and nativity of persons employed in the Pacific and Arctic whale fishery from San Francisco in 1888, including the crews on New Bedford vessels making their headquarters on the Pacific coast.

Country.	Nationality.	Nativity.
United States	1,019	727
British Provinces	248	336
Central America	3	3
South America	33	34
Mexico	5	5
Norway	33	42
Sweden	46	58
Denmark	10	11
France	20	26
Germany	91	127
Holland	7	7
Austria	2	3
Belgium	2	2
Italy	2	2
Switzerland	1	1
Russia	12	16
Spain	89	98
Portugal	65	185
Africa	1	1
China	2	2
Japan	38	38
Sandwich Islands	19	21
South Sea Islands	17	20
Total	1,765	1,765

Citizenship of native-born Americans engaged in the Pacific and Arctic whale fishery from San Francisco in 1888, including the crews on New Bedford vessels making their headquarters on the Pacific coast.

State or Territory.	No.	State or Territory.	No.
Alabama	2	Montana	1
Alaska	2	New York	129
Arizona	2	New Jersey	11
California	84	New Hampshire	4
Connecticut	20	North Carolina	3
Delaware	3	Nevada	2
District of Columbia	1	Nebraska	2
Georgia	2	Ohio	23
Illinois	28	Oregon	3
Indiana	4	Pennsylvania	47
Iowa	11	Rhode Island	13
Kansas	4	South Carolina	1
Kentucky	6	Texas	4
Louisiana	5	Tennessee	2
Maine	20	Vermont	4
Massachusetts	223	Virginia	7
Maryland	11	Wisconsin	12
Michigan	12	Washington	1
Missouri	10		
Minnesota	6	Total	727
Mississippi	2		

The remarkable fact that so many men from interior States have found their way into this fishery illustrates not only the restlessness of Americans, but suggests something of the manner in which crews of whaling vessels are collected at San Francisco and the total lack of experience of some of the men.

The San Francisco Chronicle of January 23, 1887, states:

In hiring sailors and officers for whaling voyages, the services of men designated as shipping masters are called into requisition. Various systems are resorted to to obtain men. Plying with liquor of the vilest description, doling out sufficient money to enable them to keep within the clutches of the harpies who float around the Barbary coast and water-front region, and in some cases conveying desirable men into interior towns until the ship is ready to sail, are the methods in vogue. The classes of men composing the crews are of a most heterogeneous description; men who have never seen the sea, and to whom a ship is as unfamiliar as a rhinoceros, are to be found on board of a whaler.

Besides these classes a whaling vessel has for a crew some of the greatest drunkards to be found in a large city, jail-birds, and thieves. In this mass of humanity, gathered within the confines of a forecastle, good leaven is small. The majority of those who can pull a boat at the outset of a whaling voyage are Kanakas, natives of the Caroline Islands, or men from the Azores. This class of men regard whaling as a profession.

The lower grades of officers, such as boat-steerers and boat-headers, are nearly all colored men or Portuguese from Cape de Verde Islands. As is usual with ignorant persons placed in authority, their treatment of green hands before the mast is anything but kind. The mates and masters on the vessels are, with few exceptions, Americans, hailing from New Bedford or other Eastern whaling ports. Many instances are made public of the cruelty with which the sailors are treated by these officers, but while there are, no doubt, occasions when brutality is displayed, in most cases the sailors' treatment is aggravated by their own conduct. When it is remembered that the crews of whaling ships are composed partly of a useless set of men and partly of a lot of vagabonds who speedily demoralize the others, it must be conceded that a strong hand is required to keep order and preserve discipline.

The statements above quoted may be a little overdrawn so far as their general application to the whale fishery is concerned, but they are justified by conditions which too frequently exist in connection with this industry. Still it is but just to say that much of this is unavoidable, and while other and more commendable conditions are desirable, it will be conceded that any useful employment of those who otherwise might be idle or worse must be considered of great importance, particularly when this results in the maintenance of an extensive industry.

The men are shipped on shares, as usual in the whale fishery, and they receive "long" or "short" lays, in proportion to their skill and experience. A considerable percentage of the men reship each season and because of their experience often receive better lays than those not previously employed in the fishery. But many merchant sailors or others are shipped who know nothing of whaling; their lay is usually so "long" that they must be very "lucky" to earn more than enough to "square-up" at the end of the season, since the advance received before sailing and "slop-chest" charges during the voyage are generally equal to or in excess of their earnings; indeed, the general rule

among the old hands is to secure all the advance possible before sailing, and to draw upon the "slop-chest" during the cruise as much as they are allowed to, for the majority of them think they will get nothing for their trip except the single dollar at the close of the season for "signing clear." The lay of officers, and particularly of the captain, depends largely upon their skill or success in capturing whales, but it is also influenced by the size of the vessel and the number of men in her crew; the lay on a large ship with a numerous crew is considerably "longer" than it is on a smaller craft with fewer men.

The "lay," as stated, shows the proportional part of the catch received by each individual who "signs articles." Thus a one-tenth lay—which is a very "short" one—signifies that the person who "signs" for it is to receive one-tenth of the proceeds of the voyage, while one who had a one-hundred-and-seventieth lay receives only that proportion of the catch, or one-seventeenth of the amount obtained by him who has the shorter lay of one-tenth.

The lays given to the officers and men are generally as follows: Captain, $\frac{1}{10}$ to $\frac{1}{15}$; chief mate, $\frac{1}{18}$ to $\frac{1}{25}$; second mate, $\frac{1}{18}$ to $\frac{1}{30}$; third mate, $\frac{1}{30}$ to $\frac{1}{50}$; fourth mate, $\frac{1}{40}$ to $\frac{1}{60}$; carpenter, $\frac{1}{70}$ to $\frac{1}{150}$; cooper, $\frac{1}{80}$ to $\frac{1}{100}$; cook, $\frac{1}{70}$ to $\frac{1}{150}$; steward, $\frac{1}{60}$ to $\frac{1}{125}$; blacksmith, $\frac{1}{120}$ to $\frac{1}{150}$; donkey engineer on sailing ships, $\frac{1}{100}$ and $10 per month; seamen, $\frac{1}{170}$ to $\frac{1}{200}$. The first engineer on steam whalers gets $50 per month and $\frac{1}{50}$ lay; second engineer, $25 per month and $\frac{1}{100}$ lay; and the firemen, $\frac{1}{125}$ lay.

A peculiar feature of this lay system is that the men agree upon a certain price for the oil and bone before sailing, this price being stated or fixed by the owners, and ordinarily amounting to only about half of what the products are actually worth. Wilcox learned that the price agreed upon is the basis for estimating the value of whale products in submitting returns to the customs officials, the result being that the figures are grossly erroneous.* This system of fixing prices, of course, makes the earnings of the whalemen much less than they actually would be if full market value was the basis of settlement. It is more than probable that if the full market value of the products was paid the lay would be proportionately "longer," so that the men would receive no more than now for their labor.

* Writing from San Francisco concerning this matter, under date of January 25, 1889, Wilcox stated that the returns sent in by him were made up from the books of owners and agents, and from personal interviews with them. He called attention to the fact that the custom-house returns placed the value of whalebone at $1.50 per pound, while he gave it as $3 per pound. The former was the price agreed upon by the sailors in signing shipping articles for the voyage, and the latter was from 25 to 50 cents less than the market value, but used as the most correct basis for getting actual values after allowing for culls and shrinkage, both of which must be taken into account as materially affecting receipts. The price of whale oil as given to the custom-house was 18 cents per gallon, but it was really worth 35 cents. Thus there was a difference of $553,365 in the value of whale products as furnished to customs authorities and the correct figures.

It should be borne in mind, however, that the owners in fixing the rates take the risk of any fall in the market value of the products by assuring a stated price to the men. While the chances are generally in their favor, they may meet with a loss by a sudden decline in the price of bone and oil. It should also be taken into consideration that not unfrequently vessels return without having captured a single whale, or they may be crushed in the ice, and with their cargoes and outfits become a total loss. The owners of the whaling ships, as a rule, have to make large advances to the men and take the risk of being reimbursed for their outlay at the end of the voyage. If the vessel is successful, they are paid; otherwise, not; for the men are generally irresponsible and have little consideration for liabilities contracted in this manner. There is, as a matter of course, unstinted grumbling, but after Jack has had his growl, which invariably comes after settling and "signing clear," he looks for a ship and enlists for another cruise upon the first "blubber-hunter" he can find that needs a crew.

The following, from the San Francisco Examiner (November 12, 1888), expresses Jack's view of it, and shows why many old hands continue in the business from year to year:

"It's tough [said an old salt in explanation], but it's the usual run. I've been at it 8 years now, and I've grown to expect it."

"Why don't you drop the business then?"

"Blamed if I know. You see us fellows usually sail the same old familiar course, no matter where it leads to. We growl, of course, and do some swearing, but we're usually back in the ice again the next season. I suppose it's because we don't know anything else, and because it's so hard to strike a new course." * * *

"You signed clear for $1.50, but how much did you owe the ship?"*

"Fifty-seven dollars they made it. I've been 8 years at the business, and I know enough to pull all I can out of the slop-chest while we are afloat. It never makes any difference; you only get a dollar or two when you are paid off anyhow, even if you never touch a rag. If the whaling bosses don't best you on the slop-chest they best you on estimating the catch. Go for the slop-chest, say I, and get a dud or two anyway. * * *

"Here we are after a 10-months' cruise turned ashore without a copper. We've got to live. * * * We are then in the boarding-house keeper's clutches, where the bunk bills run up. He turns us over to the whaling master and so squares our account with advanced money, and so we go the round."

The above will show that the average whaleman has a hard lot, for which he himself is largely responsible. His desire to "come square," necessarily leaves him in the power of others. One who has had experience in the business says:

It is the sailors' own fault. The first thing they do on signing articles is to draw an advance—all they can get. In order to protect ourselves we are obliged to limit

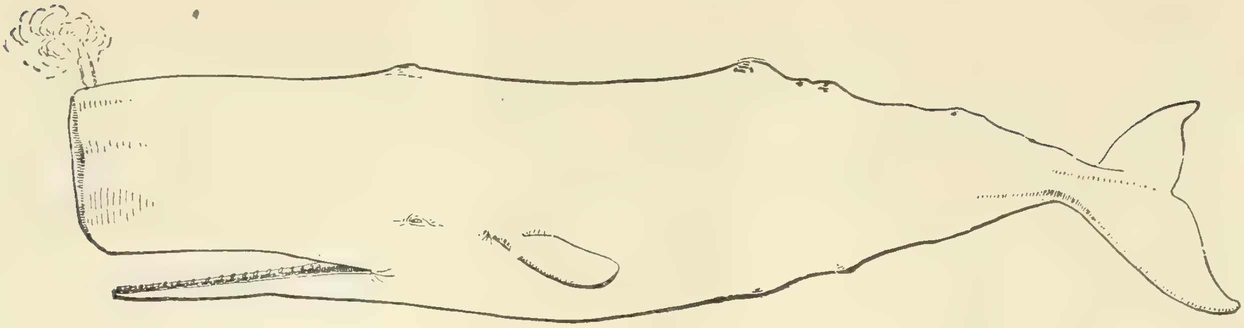
---

*Ordinarily there is nothing due to the seamen at settling, and they are paid $1 each for signing the following document, which is denominated "signing clear:"

SAN FRANCISCO, ——— —, 1888.

This is to certify that I have this day been discharged from the bark ———, ———, master, by mutual consent, and in consideration of receiving my discharge at this port I hereby acknowledge the receipt of ——— dollars in full settlement and compromise of all claim or claims I have or may have against the agents, owners, and master of said bark or vessel for services rendered by me to date.

(Signed) ——— ———.



SPERM WHALE (*Physeter macrocephalus*).

CALIFORNIA GRAY WHALE (*Rhachianectes glaucus*).

PACIFIC HUMPBACK WHALE (*Megaptera versabilis*)

SULPHUR-BOTTOM WHALE (*Sibbaldius sulfureus*).

PACIFIC RIGHT WHALE (*Balæna japonica*).)

the advance of a foremast hand to $60. I admit that the boarding-house keepers and the shippers get the most of it, but that is not our fault. Then, the hands usually come aboard with no outfit, and during the cruise they draw heavily on the slop-chest. They're a sharp lot, and if the catch is small they've usually drawn enough out to be ahead of the company at the end of the voyage.

Those who are temperate, brave, ambitious, and quick to learn the technicalities of the trade rapidly attain promotion, particularly if successful, as subordinate officers, in killing whales. Such men ultimately rise to responsible positions, as mates or masters, and nowhere can there be found those who excel them in hardihood, determined bravery, seamanship, and resource in the many trying emergencies incident to their calling. Nowhere do men meet with greater peril or more trying exigencies, and the training they get in this adventurous calling develops the highest qualities of seamanship and fits men not only to take a prominent part in this fishery, but to rise to distinction in other branches of maritime enterprise.

Species, seasons, etc.—The species chiefly sought by the San Francisco whalemen are the bowhead (*Balæna mysticetus*), the California gray (*Rhachianectes glaucus*), the right whale (*Balæna japonica*), and the sperm whale (*Physeter macrocephalus*). Occasionally a humpback may be captured, and sometimes considerable numbers of walrus are killed for their skins and ivory.

The fishing season of the Arctic fleet is usually from about the first of May to the first of October, though the vessels have sometimes stayed later, occasionally at fearful sacrifice. In some cases vessels have been caught in the ice and had to be abandoned. The fleet usually reaches the Gulf of Anadir or vicinity about the first to the middle of May. The vessels cruise south of Bering Strait until the ice breaks up sufficiently for them to force their way through the strait into the Arctic Ocean. This is generally about the first to the middle of June. The whales enter the Arctic about the first of the month, and no effort is spared to come up with them.* The vessels work along the Asiatic coast in the early part of the season, because the "leads" are usually most favor-

---

* When the whales enter the Arctic they follow up the American shore into the northeast as fast as the ice breaks up. They go, nobody knows where, but it is surmised into the great basin at the mouth of the Mackenzie River. But the eastward of Point Barrow is a dangerous region; there may not be a cake of ice in sight, yet a sudden change in the wind may bring up the pack in a twinkling. No places of retreat are at hand, for the water is shallow inshore, hence ships, if caught, would most likely be pushed high and dry on the beach. Ships of much draft drag their keels in the mud if they go so far to the eastward. One of the greatest dangers in Arctic whaling is this going east of Point Barrow. Yet the steamers and many sailing vessels venture there at every opportunity. Franklin's Return Reef is the farthest limit, though in 1886 steamers reached Barter Island and aimed at Herschel's Island, 450 miles from Point Barrow. Had they gone there, however, they would have been shut in for the winter. (From advance sheets of "Arctic Alaska and Siberia," by Herbert L. Aldrich.) Published in *Outing* for November, 1889.

able there, but they push across to Point Barrow as soon as the ice opens enough to permit them to go eastward.

From the time of entering the Arctic until Point Barrow is reached, generally about August 1, the chief occupation (it is considered a pas. time) is hunting walrus, immense herds of which are sometimes met with on the ice floes, particularly near Cape Serdze-Kamen. This period of six or seven weeks is called "between seasons" or the "summer season," and unless walrus are found it is generally devoid of profit or excitement. Occasionally whales are met with and in some seasons many have been taken in the western Arctic.

The Arctic season, properly speaking, is from the middle of August to the first of October, for during this time nearly all whales are captured. What with the frequent hairbreadth escapes of ships and men from dangers that beset them in ice, fogs, etc., and the adventures met with in killing whales, this is a period filled with excitement.

Aldrich gives the following graphic account of his recent experience on a whale ship while on a passage from San Francisco to the Arctic ocean:

"*Blow!*" "*blow!*" came down from the crow's nest late one afternoon after we had for days tacked this way and that on the lookout for whales, and incidentally also for "leads" through the ice pack, for we were in Bering Sea. It had been a long passage from San Francisco; not a sail had we seen for 52 days. No wonder, then, that we rejoiced when suddenly five sails hove in sight. But this spasm was overshadowed by a new excitement. It was a whale—the first whale! Every man was electrified. The boats were made ready to "lower away," but the whale was in too much haste to wait to be caught, and disappeared in the ice.

* * * * * * *

On the evening of the 28th of May a sail was sighted at the south and in the morning there were six more. We recognized them as part of the fleet that had gone eastward in hopes of getting north along the Alaskan coast. They had found the solid ice-pack as far south as St. Paul's Island, so returned. With them came news from ships at the south, the two chief items being that twenty-one whales had been caught and that the *Stamboul* had been stove, not so seriously, however, but that she could be repaired.

This was the slowest getting anywhere I had ever experienced. On the 1st day of May we were 100 miles below Cape Navarin. A week later we were off the Cape. Then we pressed forward and went perhaps 50 miles, but only to be beset in the pack and remain 3 days without moving a ship's length, except as the current carried us. Then a northwesterly gale carried us back below Cape Thaddeus. Four or 5 days later the ice opened sufficiently to allow of making an attempt to work northward, and in 2 weeks we had only gone about 100 miles. During these 2 weeks we had sailed north and drifted south, sailed south and drifted north; in fact, gone in every direction. One current carried us to within 60 miles of Anadir River, while another carried us off to the eastward. Finally the current settled down to a general northerly flow and carried us in a northerly direction at the rate of from 2 to 12 miles a day. Local currents occasionally interfered. Thus the 1st day of June each ship lay tied up to a big cake of ice, and of the vessels nearest us, the *Hidalgo*, which was east-southeast in the morning, was carried to south by east by night. The *Abram Barker* was carried from north by east to northeast by north, and the *Northern Light* from west half north to southwest by west.

To be bothered like this is an everyday experience to an Arctic whaleman, and it

SHOOTING A BOMB LANCE INTO A WHALE.

is a small part of what he must submit to. A contrary current may hold him in the pack while ships about him make sail and head for the whaling grounds. Or while he is wearing and tacking about, waiting an opportunity to continue his course, he is harassed by the feeling that perhaps other ships have got through the ice somewhere else and found whales. Possibly he may be within easy sailing of a passage through the ice—as it was afterward learned we seventeen ships were—but not know it. He is always in danger of having his ship stove, and must be prepared at any moment, day or night, to fight clear of ice or flee from a threatened pack or approaching floe. These conditions come nearer the proper ones for spoiling a good temperament than any human being ought to be tempted with. Even the patient Job of old would have been sorely tried had he been an Arctic whaleman. To hang week after week on the verge of getting somewhere is far more trying to the patience than one could imagine who has not experienced it.

An experience of Captain Cogan, of the *Hunter*, in 1886, is typical of what exertion a whaleman will make to prosecute and complete his voyage. In going through the Gulf of Anadir he broke a piece out of the *Hunter's* cutwater, but did not deem it necessary to stop and repair it. When off St. Lawrence Island he was caught in a whirlpool, had the rudderhead nearly twisted off, and two of the pintles holding the rudder broken. It was necessary to make this damage good, when he started on again. When off Icy Cape he struck bottom ice, knocking in six timbers 6 feet from the keel forward of the fore chains. This caused a serious leak, but by running all pumps and bailing he got at the break and stopped two-thirds of the flow. Turning about he went into Kotzebue Sound, behind Chamisso Island. The wind has a rake of 10 or 12 miles there, yet it was the last retreat at hand. Nearly everything in the ship was landed on shore. The spars were then unshipped and made into a raft, which was firmly anchored at both ends with the two anchors and then weighted down and steadied with casks of water. A strong southeasterly gale came up, making it necessary to undo all this work. But when all was again quiet the raft was rebuilt, and with this as a wharf the ship was hove down so that the keel could be reached, and the leak thoroughly repaired. Before things were stowed down again, another southeaster came on, but it was too late to do any damage. Up to the time of this mishap the *Hunter* had not caught a whale, but less than three months afterward she went into port with eleven whales. ("Arctic Alaska and Siberia," by Herbert L. Aldrich.)

The season in the Okhotsk usually begins about the last of May to the first of July, and continues to the latter part of October. The whalers enter the sea as soon as the ice permits; occasionally they have continued there until near the close of November, though in imminent danger from the new ice. Vessels have on rare occasions "wintered in the ice, in order to take advantage of the late and early seasons." The whaling season on the "Japan ground" is commonly from May to November, or essentially the same as in more northern regions. In late years, however, the whale fishery from San Francisco has been prosecuted chiefly in the Arctic Ocean and the Okhotsk Sea.

It is common for vessels to "fit away" and sail on voyages in the late autumn or early winter. The chief object is to have their crews on board and well trained before the Arctic season begins. They cruise in the Pacific and occasionally make profitable captures, though, as a rule, few whales are taken in winter. "Leaving port the whaler cruises for a while in the tropics under easy sail hunting for sperm whales, winding up for a holiday at the Sandwich Islands, or some other island port, before the ship's head is turned northward."

Boats and apparatus of capture.—A full description of the boats and apparatus would occupy more space than is available; therefore for detailed information reference is made to the admirable treatise by James Templeman Brown on "The Whalemen, Vessels, and Boats, Apparatus, and Methods of the Whale Fishery" (vol. II, section V, "Fisheries and Fishery Industries of the United States," pp. 218–318.)

The typical whaleboat propelled by oars and sails is still in favor and universally employed. That it has held its own in this age of innovation and invention is sufficient evidence of its excellent qualities and the high degree of specialization which it attained many years ago.

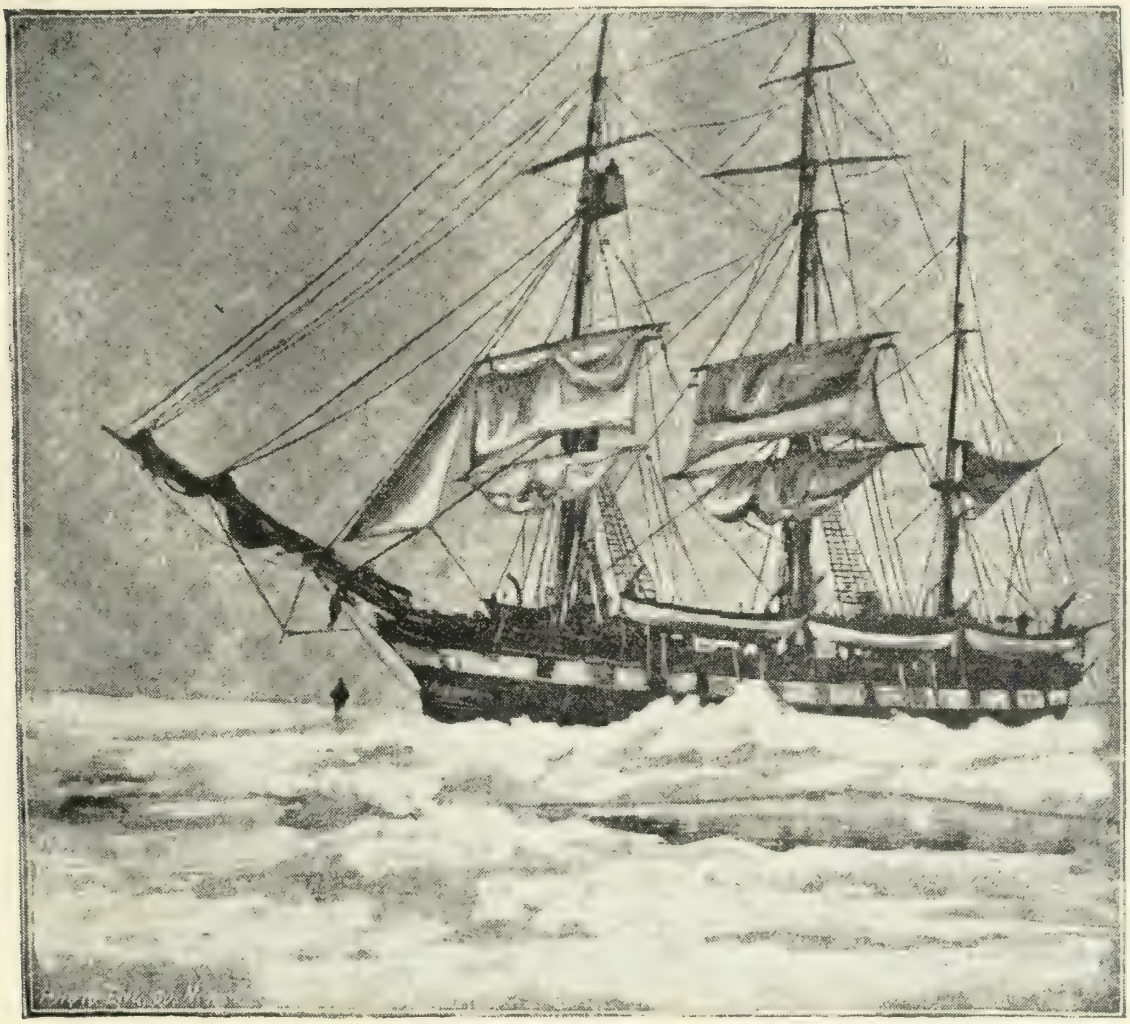
In 1882, according to Brown, a very noticeable innovation was suggested by Lieut. Commander Z. L. Tanner, U. S. Navy, who is now in command of the U. S. Fish Commission steamer *Albatross*.

During the "season" in the Arctic calms or light winds are often prevalent, and at such times it is difficult and generally impossible for sailing ships to reach the vicinity of whales seen many miles distant. Without steam launches the only available course is to row the boats to the point where the whales are seen, which is frequently a distance of 8 or 10 miles from the ship. The desire to reach them in advance of others, or before they disappear in the ice, prompts the crews to put forth every possible effort, the consequence usually being that the men are exhausted with pulling before they come up with the whales, and thus are often more or less unfitted for the arduous and dangerous duty of effecting captures, and the still more laborious task of towing dead whales to the ship.

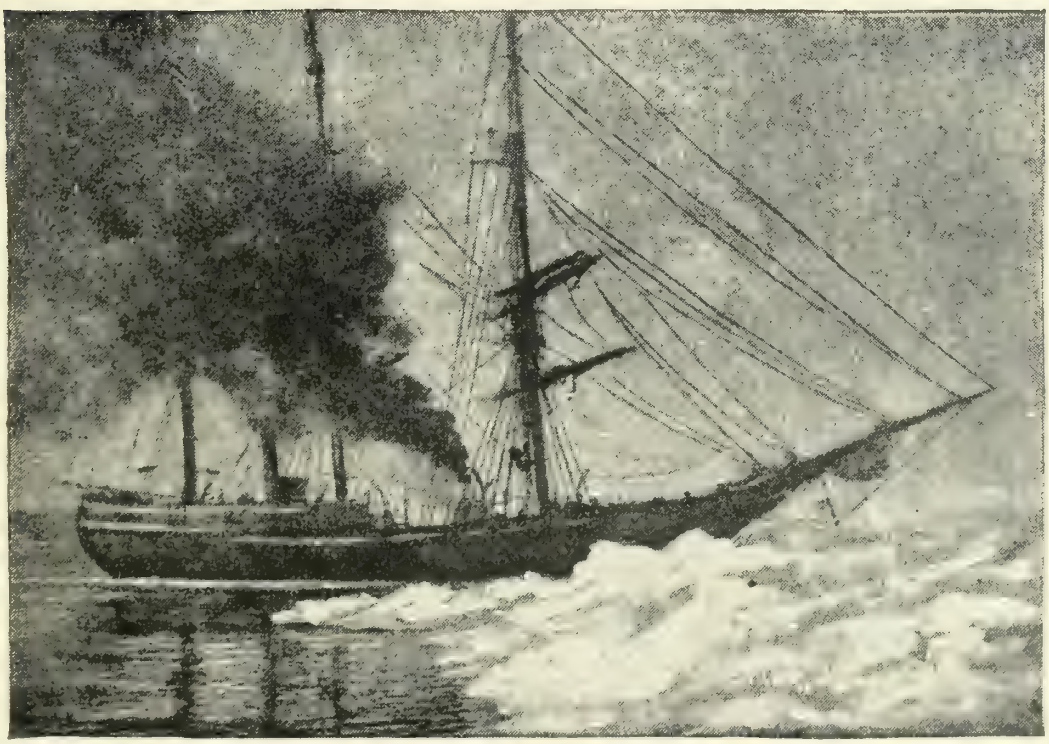
The thought occurred to Captain Tanner that under such circumstances a steam whaleboat could be most effectively used to tow the other boats rapidly to the scene of action, so that the men could begin their work in a fresh and vigorous condition, with much greater assurances of success. In like manner the whales and boats could be towed to the ship by the launch, or, if more convenient, the ship could be brought to the whales. The idea was a good one, and but for the peculiar conditions under which the fishery is prosecuted complete success would doubtless have been attained.

The firm of I. H. Bartlett & Sons, of New Bedford, made the first experiment with steam-launches (building one in 1882), and others soon tried them. These boats were built in New Bedford at an average cost of $1,250. They had oak frames and cedar plank; were sharp aft like a whaleboat, and were fitted with coil boilers of the Herreshoff pattern; the screw propeller was amidships, and so arranged that it would fold into the keel whenever it was necessary to go upon a beach or ice. The dimensions were as follows: Length, from 30 to 32 feet; beam, 7½ to 8 feet; depth, 4 feet. The first one built was 28 feet long and 7 feet wide.

So far as can be learned the use of these launches has been to some extent discontinued. It was soon found in practice that the service



WHALER IN THE ICE.
(From Aldrich's "Arctic Alaska and Siberia.")



TRYING OUT.
(From Aldrich's "Arctic Alaska and Siberia.")

actually performed was small compared with the extra expense for cost of building and hire of engineers to run them, added to which was the time consumed in making necessary repairs to engines, etc. While in good condition they were often of great service in towing boats and whales in moderate weather, but frequently they were out of repair when most needed. Mr. Aldrich, however, mentions the steam-launch upon the ship he sailed on in 1887, and frequently refers to its employment in killing whales.

The toggle harpoon, the hand lance, the whale gun, and the explosive bomb lance are the apparatus chiefly relied upon for killing whales. These have been so fully and so frequently described by others that it is only necessary to briefly mention them here.

The necessities in the Arctic whale fishery have led to the invention of bomb guns. The tendency of whales in northern regions is to dive under the ice after being struck, and this is little to be wondered at when ice floes are usually near on all sides. With the old methods of whaling with harpoons and hand lances it was difficult and often impossible to kill whales quick enough to prevent their escape. This resulted in the introduction of guns and the shooting of explosive bomb lances into whales, which are now usually killed in a very short time by a well-directed shot. Two kinds of guns are used. One of these, the "Pierce gun," is commonly called a "darting gun." "Were it not for this kind of gun," says Brown, "ice-whaling could not be successfully pursued." This consists of a stockless gun barrel, which holds the powder and bomb, attached to the harpoon in such a manner that when the iron enters a whale the gun is discharged, driving the bomb deep into the animal.

A shoulder gun is also in favor, and is generally used in conjunction with the hand-thrown toggle harpoon. After a whale has been "fastened to," at the first opportunity a bomb lance is shot into him, and this is continued on every favorable occasion until he succumbs.

Methods of capture, preparation of products, etc.—The greatest care is exercised in approaching whales, for these animals have grown shy from being hunted so much, and the least noise will make it impossible to get near them. Whenever there is wind the boats get to windward and then sail down upon a whale, and the utmost silence is preserved until the harpoon is thrown, when the sheets fly off and "Starn all!" is the order to the men waiting with oars ready to drop them into the water and drive the boat astern beyond the reach of the whale's flukes, that otherwise may sweep round with terrible force and smash a boat into splinters.

The following, from the pen of one who has recently (1887) participated in the Arctic whale fishery and personally witnessed its methods, may be appropriately quoted here:

The day was beautiful, and the captain and I embraced the opportunity to make the round of the nine ships at anchor. When on the extreme northern ship a whale

was "raised" or seen coming leisurely along the edge of the shore ice. The news spread like wildfire, and in a few minutes thirty or more whaleboats were flitting about, each endeavoring to get as near as possible to the spot where the whale would next rise to spout.

When he rose a boat darted an iron, but it did not hold. At the next rising another boat attempted to hit, and also failed; but the third boat made fast to him. It was a grand sight to see the whale make a lunge and start seaward, towing the boat after him at a terrific pace. He went a mile or two, then wheeled about and made a straight line for the shore ice. Another boat was soon alongside to bend on more line to the nearly exhausted tubs of the first boat.

All the captains became so excited and interested in the chase that they longed for some of the fun; so four of them took the *Hunter's* steam launch, I accompanying them. As soon as we reached the shore ice I saw the whale spout behind a long point of ice. It would have taken a boat a considerable time to sail there, but we steamed around it and, before I could comprehend the situation, were alongside the monster. It seemed incredible that such a powerful creature could be killed. With Captain Cogan at the helm, Captain Sherman with a darting gun, Captain Kelly with a shoulder gun, and Captain Winslow and myself as ballast, we bore down on him, fired two bombs into him, and rushed past just in time to escape a sweeping blow from his powerful tail.

It is disappointing to see a whale, for most pictures represent him as standing up like a buoy or posing with his tail on top of the water. The real fact is that only the top of the head about the spout hole and a small piece of the back are seen, and perhaps the "flukes" or, in common English, the tail may take an occasional sweep in the air. When as near as we were, so that we could look down into the water upon the creature, his great size could be partially comprehended.

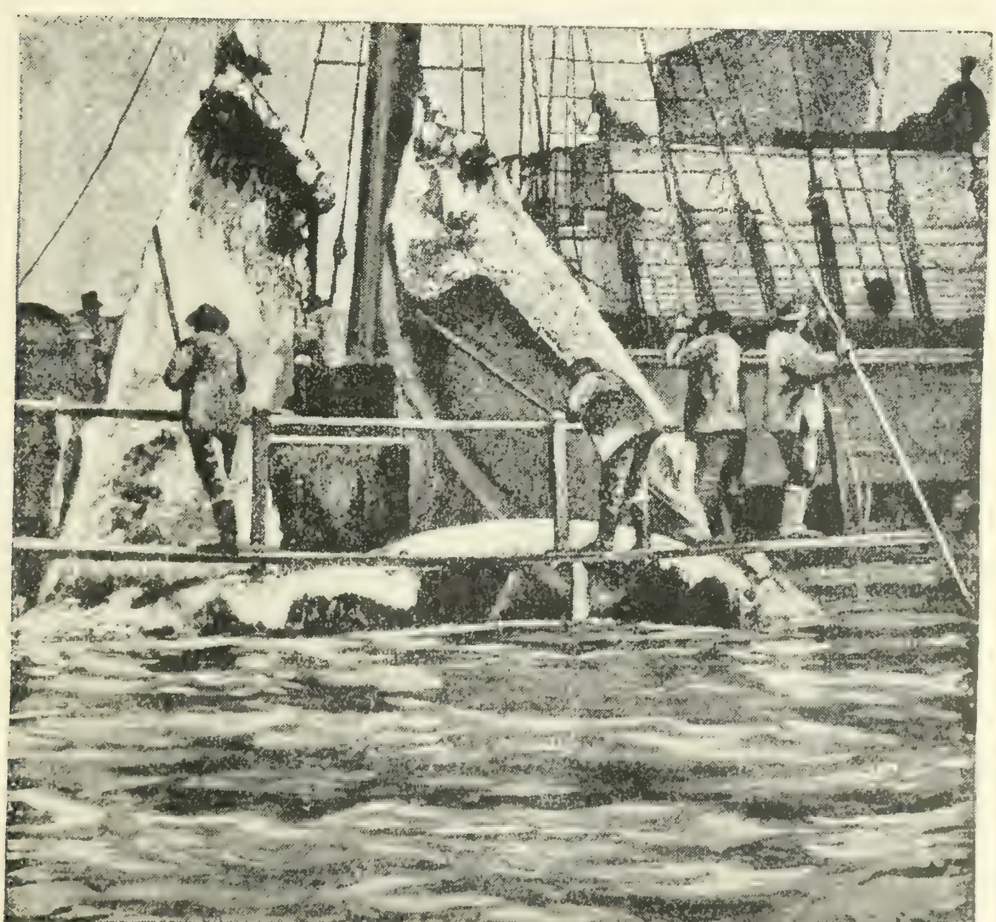
It seems to be the duty of every man in the boat when the whale is struck to yell at the top of his voice. Even where there is dignity to be kept up, a certain amount of this has to be done. In the midst of the shouting was heard the muffled "boom," "boom" of the two bombs, and the whale rolled over dead without a struggle. I staid aboard the *Lucretia* that night to see the whale cut in.

As soon as a whale is killed the vessel gets under way and sails to him, taking him on the starboard side in front of the gangway. With a steamer, as in this instance, this is very easily done, but a sailing vessel may find it necessary to maneuver some time before getting the conditions right for work. First, a strong chain or hawser is secured around the flukes. This runs through the hawse pipe and is firmly fastened to the forward bitt near the windlass. Then another chain is secured to one fin, and it is with this second chain that the whale is managed.

The carcass runs fore and aft, the head being aft, and the fin in front of the gangway. With sharp cutting spades a man cuts through the blubber, circling around the whale from the extremity of the mouth toward the tail, corkscrew like. He cuts down to the "lean." By hauling on the fin chain the carcass rolls, and the "blanket piece" of blubber tears itself off, aided by the cutting spades. When the whale is rolled quarter over one lip comes uppermost. A tackle is fastened to this, then it is cut off, hoisted on deck, and dropped into the "blubber room," as the space between decks from the mainmast to the forecastle is called. All hoisting is done by the windlass, and in most of the vessels power comes from a donkey engine. The blanket piece is started again and the whale rolled half way over. The throat is then uppermost. This in turn is cut off and deposited in the blubber room, then the other lips rolled up and removed. By this time the blanket piece becomes unwieldy in its length, so another hold is secured close down to the carcass [by hooking on another tackle], and the strip of blubber, perhaps 15 feet long and 6 feet wide, cut off and dropped into the blubber room.

The most difficult part of the whole operation is now at hand, and that is to cut off the "head" or upper jaw, which contains all the whalebone. A false or careless move

TAKING IN A BLANKET PIECE.
(From Aldrich's "Arctic Alaska and Siberia.")



CUTTING IN A LIP.
(From Aldrich's "Arctic Alaska and Siberia.")

might destroy hundreds of dollars' worth of bone, or, possibly, cause the loss of the whole head. A chain is carefully drawn through a hole cut between the scalp bone and the tough blubber about the spout hole. The backbone is chopped nearly through near where the blanket piece was started, then by a jerk of the tackle the weight breaks the remainder and the head is hauled on deck. There was once a whaling captain who disjointed the head instead of chopping it off. My whale's head contained about 2,500 pounds of whalebone, and as the price of bone was $3.50 a pound at that time, it can readily be seen how anxious a whaleman must be when cutting in until he gets the head on deck. Heads contain over six hundred slabs of bone, and in a large whale like this the pieces range in length from 12 feet, or a little over, down to a few inches. For convenience in working each ship has a "cutting stage" of planks that hangs over the water in front of the gangway so that the men can stand nearly over the whale. It is from this that the work is done, and it was here that I stood to see the whole operation.

With the head cut off, the rest of the cutting in is easy and simple. The blanket piece is peeled off in strips about 15 feet long, until a point near the flukes is reached. There the backbone is disjointed. The final haul brings on deck the flukes with the blanket piece. The carcass either floats off or sinks. These blanket pieces of blubber are cut and torn off the whale in the same manner that the peel is cut and torn off an orange when paring it. Frequently the natives are aboard, and work is done slowly in order that they may have an opportunity to cut off as much as possible of the lean meat. The cutting in was a novelty to me, but the work of the natives was more entertaining. They had six canoes crowded in near the whale, and the instant there was a lull in the procedings, a man from each would clamber onto the carcass, splash about in the blood and water, and slash away at the meat with villainous-looking knives. They worked like heroes and yelled like fiends. Some worked with their hands under water, and most of them were knee-deep in it all the time. One fellow lay almost flat on his stomach and burrowed in under the blubber in advance of the cutters. His feet were flying about dangerously near keen-edged knives, but he did not get cut.

Whalemen still observe the old sperm-whaling custom of lustily shouting "Hurrah for five and forty more!" when the head or last piece of blubber is landed on deck. But this shout is not because the work is all done. Early the next morning the try-pots were set to working. First, the blubber was cut into "horse pieces" about a foot square and 2 feet long, then "minced," that is, cut into thin slices to facilitate the trying out of the oil. The blubber then goes in the pots, and after the oil is boiled the remains of the blubber have become hard and brittle, but are pressed to get the last dregs of oil; then these "scraps" are used for fuel, and they make a hot fire. This night the sun barely dipped below the horizon at midnight, but when darkness does interfere with a trying-out, a lot of scraps are put into a wire basket and lighted, making a "bug light," which is equal to a pitch-pine torch. The oil is slowly baled from the try-pots into a cooler, and after running through two or three is pumped into casks and stowed down into the hold. This whale made 120 barrels of oil. ("Arctic Alaska and Siberia," by Herbert L. Aldrich.)

While the method of trying-out described above is the orthodox one, and the old-timed "try-pot" and scrap fires are still in most common use, an improved plan of trying out the blubber by means of steam digesters has been adopted on some of the steam whalers.

When boiling the men usually have watch and watch, each watch working 6 hours and resting 6 hours. Ordinarily the Arctic whalemen arrange so that one watch has 8 hours on deck one night and 4 hours during the next day, while the other watch gets the 8 hours "below" at night. The change or alteration of watches that occurs every

night by the introduction of the "dog-watches" makes the matter even, so that each watch has the 8 hours off duty each alternate night. But when whales are raised no regard is had for the "watch below," and all hands tumble out and are on the alert when the cry of "There she blows!" resounds through the ship. While the trying-out proceeds, the boat-steerers improve all chances they get to put their boats in order and to arrange harpoons, lines, etc., for another capture.

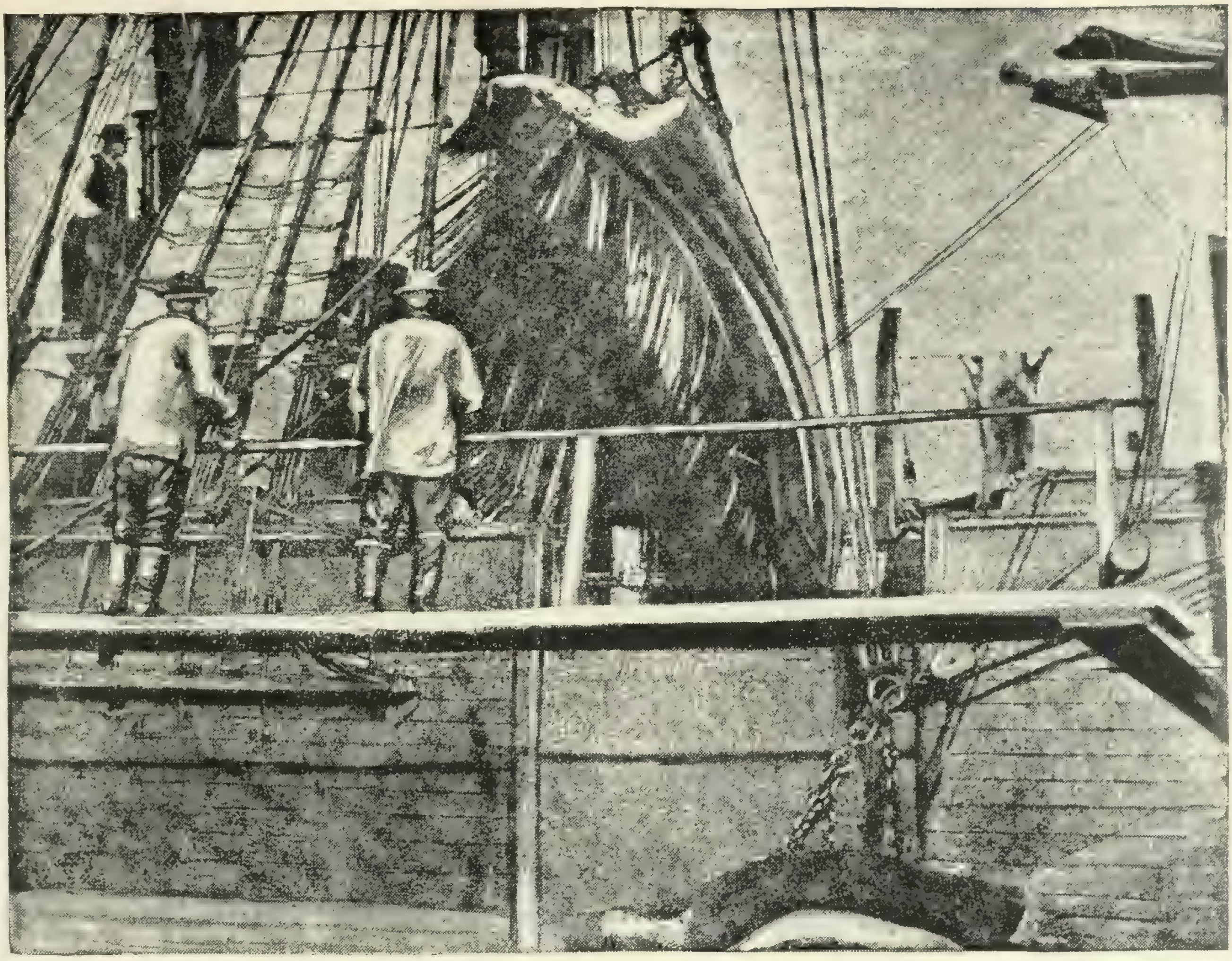
The bone is by far the most valuable portion of a baleen whale and receives special attention. Some of the small schooners hunt for bone only, and make no attempt to save the blubber of whales captured by them, but give this away to larger craft, if any chance to be near. Such vessels are called "bone-hunters." When the head of a bowhead or right whale has been hoisted on deck, the whalebone is taken from it by cutting into the gums, to which the baleen is attached. As a rule the gums are taken out in sections, each of which has ten slabs of bone; these are thrown into the hold, and later the bone is scraped, washed, and packed away in a condition ready for market.

A correspondent of the New York *Herald* of November 6, 1887, writing from Bering Strait, under date of October 7, makes the following remarks concerning a noticeable feature in whalebone taken that year:

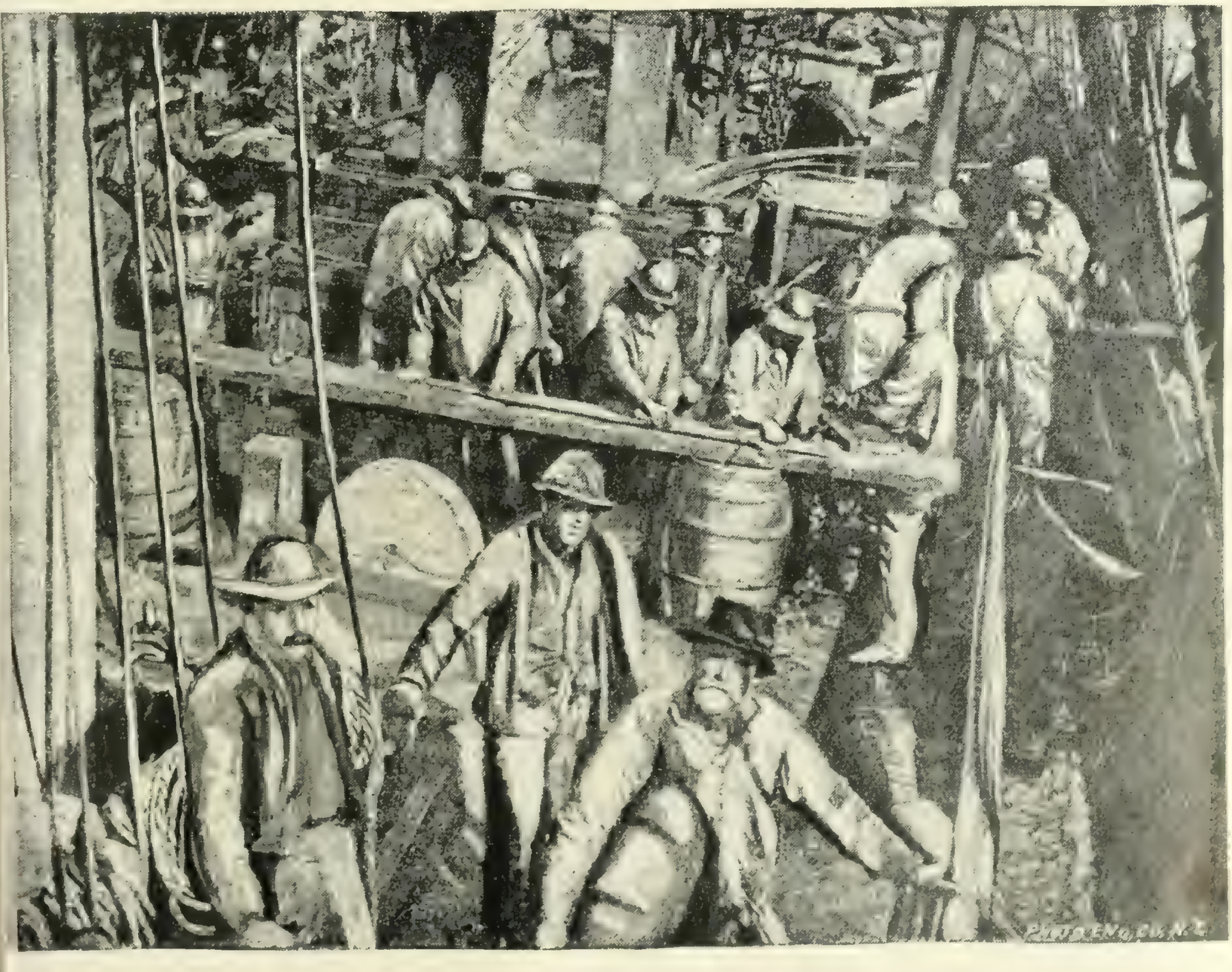
> Another feature of the whaling this season has been the amount of white whalebone taken, and in nearly every instance, if not all, it has been found in the bulls of 70 to 100 barrels. Whether it is a peculiarity of the sex could not be learned. Many whalemen have believed it to be a freak of nature, but with as many cases as have occurred this year there must be some specific cause for it.

Despite the hard work of cutting in, trying-out, and cleaning bone, the slipping about on greasy decks, and the unsavory odors from the try works, these occasions are generally the gala days of the whaleman's life, for he has a "share" in every gallon of oil and every pound of bone that goes into the hold. But when the sun has turned on her southward course, the short Arctic summer is passed, and gales of autumn come with icy chilliness, quickly freezing every drop of spray that flies, when "young ice" is forming and the ship is perhaps scudding away to escape the danger of being caught helpless in its grasp, then trying-out becomes a serious and uncomfortable duty that it would be difficult to keep men engaged upon were it not for the personal interest each has in the proceeds.

Tenders.—The employment of steam-whalers, the ordinary requirements of the trade, and the dangers which beset the whalemen in the fall, when the vessels are liable to be nipped and crushed in the ice, have made it expedient to employ "tenders" to carry supplies to the Arctic fleet and to bring home such part of the catch as it is most convenient to send by freight. This usually consists of bone, which is the most valuable and the least bulky part of the products. Rendezvouses have been established at Point Hope, in about 68° north latitude; at Point Clarence, in about 65° north; and at Point Barrow, in latitude 70° 20′.



HOISTING IN A HEAD OF WHALEBONE.
(From Aldrich's "Arctic Alaska and Siberia.")



CLEANING WHALEBONE.
(From Aldrich's "Arctic Alaska and Siberia.")

The tenders generally reach the fleet early in July and bring home the first fruits of the fishery late in August. They also bring the first news from the fleet, which is awaited with much anxiety, as indicating what the season's catch may be.

The tenders are usually large vessels. In 1888 the steamer *Jeanie* (862.95 tons) and the sailing bark *Thomas Pope* (226.86 tons) were tenders to the Arctic fleet.

In the tables which follow, giving the names, tonnage, catch, etc., of the San Francisco whaling fleet, and also the New Bedford vessels that rendezvous at that port, it will perhaps be noticed that some of the ships brought in oil and no bone, while others reported only bone. This is in part due to the fact that a portion of the catch had been shipped home in the tenders, though some of the vessels, particularly the schooners, do not save anything except the bone. Sometimes sperm oil taken on the winter's cruise in the Pacific, before entering the Arctic, constitutes a part of their cargoes.

In good seasons the tenders often bring home very valuable cargoes, but at other times they have little return freight. In 1888 the steam tender *Jeanie* brought home 2,800 pounds of bone and 75 barrels of sperm oil from the *Hunter*. The *Thomas Pope* returned with the following quantities of bone from the vessels named: *Abram Barker*, 2,300 pounds; *Helen Mar*, 300 pounds; *J. A. Howland*, 4,400 pounds; *Mary and Susan*, 700 pounds; *Ocean*, 4,100 pounds; *Reindeer*, 3,600 pounds; *Rosario*, 5,600 pounds; *Young Phœnix*, 2,300 pounds.

Trade.—It occasionally happens that the whalers obtain furs by bartering with the natives. The Eskimo are said to be very fond of trading. They often visit the whalers in their kaiaks, and bring anything they may have for sale. Fox skins are the principal furs obtained in this manner by whalemen, and the quantity is seldom large. About 50 to 60 pelts are occasionally secured. In 1888 the bark *Wanderer* brought home 40 fox skins and the pelages of 48 lynxes, 2 bears, and 10 otters.

Dangers.—No class of men are exposed to greater or more diversified peril than the Arctic whalemen. Comparatively recent years have witnessed most appalling disasters to the Arctic fleet. Many vessels have been nipped; some have been deserted by their crews that succeeded in reaching safety on other ships, but in far too many instances the men had no escape and finally succumbed to starvation or the rigors of an Arctic winter. Shipwrecks, "stove boats," etc., with all their attendant horrors, are commonplace events in the whaleman's life, and pages might be filled with the most startling recitals of disaster and suffering.

Financial results, catch, etc.—The catch, upon which depends the financial results of the whale fishery, varies exceedingly from year to year, the fluctuations being due to many causes, but chiefly dependent upon the movements of ice and whales in the Arctic. A successful season may be followed by one that is specially unfavorable, and *vice*

versa. Nothing is more uncertain, and it is impossible at the beginning of a season for the most experienced to tell how it will turn out. There is also the utmost diversity in the fortunes of individual vessels. One ship may return "clean," without a gallon of oil or pound of bone, while another will arrive heavily laden with a cargo worth tens of thousands of dollars.

The season of 1885 was one of the most successful of recent years. Many vessels did well, and some made very large stocks. The season of 1887 was also remarkable for a big catch and some extraordinary voyages, notwithstanding the early reports were unfavorable. On November 15 the San Francisco *Examiner* made the following statement:

> An official report of the whaling vessels for the season shows that a total of 300 whales have been taken. The catch of the 39 now in port shows a result of 32,334 barrels of oil, 544,352 pounds of bone, and 550 pounds of ivory. The *Ocean* brought 450 barrels of oil and about 11,000 pounds of bone. This will bring the value of the total catch to nearly $2,000,000.*

Among the fortunate vessels was the steam-whaler *Orca*, which arrived at San Francisco October 25, 1887. It had the bone and oil of 28 whales, and might have caught others if there had been any more room on board. As each whale is worth $5,000, it will be seen that the *Orca* made a gross return to its owners of $140,000 this season. The next best catch to that of the *Orca* was made in 1880 by the *Mary and Helen*, of New Bedford, which caught 27 whales. The steam-whaler *Thrasher* was reported to have taken 25 whales by October 22, 1887.

In 1888 the whale fleet consisted of 58 vessels, including tenders, of which 5 vessels cruised in the Japan and Okhotsk Seas, 3 in the South Pacific Ocean, and 50 in Bering Sea and the Arctic Ocean (of which 11 were steam-whalers), the catch being 16,371 barrels of oil and 325,050 pounds of whalebone. The number of whales taken by the entire fleet reached 202, against 360 the previous year.

The catch for the season of 1889 was very light compared with previous years, and several vessels came home "clean," while others had only a small amount aboard. The details are shown in the tables. It is sufficient to say here that the fleet numbered 28 vessels from San Francisco and 23 from New Bedford, a total of 51, carrying 1,765 officers and seamen; 40 of these cruised in Bering Sea and the Arctic Ocean, while the others fished exclusively in the Okhotsk Sea and on the Japan ground. Only 71 whales were taken by the Arctic fleet, while 76 were captured on the Okhotsk and Japan grounds.

From the foregoing it will be seen that the financial results of the San Francisco whale fishery are important factors in the business of the city and make this industry one of the most important maritime enterprises of the port.

---

* This includes, of course (as for 1885), the catch of the New Bedford fleet, which, together with the San Francisco fleet, made the 39 vessels alluded to.

The details of the whale fishery in 1888 and 1889 are given in the following tables, in which the San Francisco and New Bedford fleets are shown separately:

The San Francisco whale fleet in 1888.

Name of vessel.	Rig.	Net tonnage.	No. of crew.	Whaling grounds.	Products landed.			
					Gallons of sperm oil.	Gallons of whale oil.	Pounds of bone.	Value.
Balæna	Str	389.67	45	Bering Sea and Arctic Ocean.	....	32,000	22,000	$77,200.00
Beluga *a*	Str	409.49	45	....do	....	28,350	18,000	63,922.50
Grampus	Str	250.26	42	....do	....	7,260	5,000	17,541.00
Jeanie *b*	Str	862.95	17	....do	....	....	....	....
Jesse H. Freeman	Str	359.80	45	....do	....	5,558	4,213	14,584.30
Narwhal	Str	389.67	46	....do	....	21,900	10,000	37,665.00
Orca	Str	462.39	44	....do	....	53,550	35,000	123,742.50
Thrasher *c*	Str	343.01	42	....do	....	11,175	8,000	27,911.25
Bounding Billow	Bark	227.83	32	....do	....	6,300	3,500	12,705.00
Coral *a*	Bark	343.48	37	Okhotsk and Japan Seas.	3,721	15,750	6,000	25,559.05
Emma F. Harriman	Bark	366.10	37	....do	....	11,025	3,500	14,358.75
Eliza	Bark	281.71	38	Bering Sea and Arctic Ocean.	449	12,600	14,000	46,656.95
Francis Palmer	Bark	200.16	35	....do	....	....	....	....
Helen Mar	Bark	308.13	38	....do	....	....	300	900.00
Hunter	Bark	337.38	42	....do	2,362	15,750	14,800	51,211.60
John and Winthrop	Bark	321.38	16	....do	1,102	6,772	....	2,976.30
John P. West	Bark	335.64	38	....do	....	7,875	5,000	17,756.25
Northern Light	Bark	365.42	40	....do	....	5,512	3,500	12,429.20
Sea Breeze	Bark	307.24	30	....do	....	14,962	13,000	44,236.70
Stamboul	Bark	247.42	37	Okhotsk and Japan Seas.	450	7,056	4,000	14,717.10
Thomas Pope *b*	Bark	215.67	11	Bering Sea and Arctic Ocean.	....	....	....	....
Wanderer *d*	Bark	288.13	40	....do	....	....	50	150.00
Alton *e*	Sch	84.39	21	....do	....	1,260	2,000	6,441.00
James A. Hamilton	Sch	73.91	20	....do	....	....	....	....
Jane Gray *f*	Sch	107.07	20	....do	....	....	....	....
Rosario *g*	Sch	141.25	23	....do	....	....	12,787	38,361.00
Ino *h*	Sch	92.94	22	....do	....	....	6,100	18,300.00
Hidalgo *i*	Brig	165.97	29	....do	....	1,870	4,000	12,654.50
Total	....	8,278.46	932	....	8,084	266,525	194,750	681,979.95

The New Bedford whale fleet rendezvousing at San Francisco in 1888.

Name of vessel.	Rig.	Net tonnage.	No. of crew.	Whaling grounds.	Gallons of sperm oil.	Gallons of whale oil.	Pounds of bone.	Value.
Belvedere	Str	339.37	45	Bering Sea and Arctic Ocean.	....	18,900	7,500	$29,115.00
Lucretia	Str	275.81	45	....do	....	4,725	3,000	10,653.75
William Lewis	Str	332.04	41	....do	....	....	....	....
Abraham Barker	Bark	361.00	40	....do	....	3,150	....	1,102.50
Andrew Hicks	Bark	287.96	37	....do	1,890	17,325	14,300	50,003.25
Alaska	Bark	323.00	29	....do	....	....	....	....
Bertha	Bark	168.51	27	....do	....	....	....	....
Charles W. Morgan	Bark	298.06	35	....do	4,252	12,285	4,500	20,138.35
Cape Horn Pigeon	Bark	201.42	31	Okhotsk and Japan Seas.	....	27,562	9,700	38,746.70
Fleetwing	Bark	311.15	35	Bering Sea and Arctic Ocean.	....	....	....	....
Josephine	Bark	365.32	37	Okhotsk and Japan Seas.	....	26,675	9,000	36,336.25
James Allen	Bark	330.98	20	South Pacific Ocean.	94	....	....	51.70

a 50 fox skins in cargo.
b Tender to the fleet.
c 500 pounds of walrus ivory landed.
d 40 fox skins, 48 lynx skins, 2 bear skins, and 10 otter skins in cargo.
e 400 pounds of walrus ivory landed.
f Abandoned at sea; vessel picked up.
g Killed 36 walrus, yielding 6,000 pounds of hides and 110 pounds of ivory.
h Vessel lost; crew saved.
i 300 pounds of walrus ivory landed.

The New Bedford whale fleet rendezvousing at San Francisco in 1888—Continued.

Name of vessel.	Rig.	Net tonnage.	No. of crew.	Whaling grounds.	Products landed.			
					Gallons of sperm oil.	Gallons of whale oil.	Pounds of bone.	Value.
Jacob A. Howland	Bark	337. 41	40	Bering Sea and Arctic Ocean.		17, 010	14, 400	$49, 153. 50
Lancer	Bark	280. 75	36	....do		7, 088	8, 700	28, 580. 80
Lagoda	Bark	352. 29	39	South Pacific Ocean.	5, 300	2, 420		3, 762. 00
Lydia	Bark	313. 28	38	Bering Sea and Arctic Ocean.		15, 000	5, 400	21, 450. 00
Mars	Bark	243. 44	34	....do		14, 175	10, 000	34, 961. 25
Ocean	Bark	274. 32	34	....do		16, 600	11, 600	40, 610. 00
Ohio	Bark	195. 37	32	....do				
Ohio 2d	Bark	344. 93	39	....do		7, 560	5, 700	19, 746. 00
Reindeer	Bark	339. 62	31	....do		14, 175	10, 500	36, 461. 25
Sea Ranger	Bark	259. 46	31	....do				
Triton	Bark	251. 60	37	....do	1, 575			866. 25
Tamerlane	Bark	353. 87	23	....do	2, 205			1, 212. 75
William Baylies	Bark	308. 83	40	....do		21, 127	13, 000	46, 394. 45
Mary and Susan	Bark	311. 01	40	....do			700	2, 100. 00
Young Phœnix	Bark	337. 63	40	....do			2, 300	6, 900. 00
James Arnold	Ship	328. 55	37	South Pacific Ocean.				
Niger	Ship	391. 11	36	Bering Sea and Arctic Ocean.				
Alexander	Brig	128. 88	25	....do				
Total		8, 946. 97	1, 054		15, 316	225, 777	130, 300	478, 345. 75

The San Francisco whale fleet in 1889.

Name of vessel.	Rig.	Net tonnage.	No. of crew.	Whaling grounds.	No. of whales taken.	Products landed.		
						Gallons of oil.	Pounds of bone.	Value.
Balæna	Str	389. 67	45	Bering Sea and Arctic Ocean.	2	7, 088	5, 324	$20, 866
Beluga	Str	409. 49	45	....do	2	7, 781	4, 571	18, 576
Grampus	Str	250. 26	42	....do	2	5, 198	5, 125	19, 452
Narwhal	Str	389. 67	46	....do	8	22, 680	14, 216	57, 180
Orca	Str	462. 39	44	....do	4	8, 253	4, 244	17, 648
Thrasher	Str	343. 01	42	....do	12	27, 405	18, 691	74, 237
Jesse H. Freeman	Str	359. 80	44	....do	2	2, 331	2, 748	10, 252
Wanderer	Bark	288. 13	40	....do	½	1, 922	1, 045	4, 303
Bounding Billow	Bark	227. 83	32	....do				
Eliza	Bark	281. 71	38	....do	1	4, 095	1, 600	7, 037
Helen Mar	Bark	308. 13	38	....do	2	5, 040	5, 200	19, 646
Northern Light	Bark	365. 42	40	....do	3½	9, 450	7, 215	28, 217
Hunter	Bark	337. 38	42	....do	1	5, 513	3, 210	13, 064
Sea Breeze	Bark	307. 24	30	....do				
James Allen	Bark	330. 98	32	....do	2	2, 835	8, 800	31, 026
Thomas Pope*	Bark	215. 52	11	....do				
Coral	Bark	343. 47	37	Okhotsk and Japan Seas.	10	37, 800	13, 000	58, 942
Stamboul	Bark	247. 42	37	....do	6	18, 900	6, 700	30, 151
John P. West	Bark	335. 64	38	....do	11	23, 625	8, 000	36, 414
Emma F. Harriman†	Bark	366. 10	37	....do	8	31, 500	13, 000	56, 485
John and Winthrop*	Bark	321. 38	16	....do				
Hidalgo	Brig	165. 96	29	Bering Sea and Arctic Ocean.				
Rosario	Sch	141. 25	23	....do	1	3, 150	3, 150	11, 939
La Ninfa	Sch	119. 91	22	....do	1	315	2, 100	7, 263
Mary H. Thomas	Sch	93. 08	22	....do			1, 500	5, 100
Jane Gray	Sch	107. 07	20	....do	1	3, 150	1, 600	6, 669
Alton	Sch	84. 39	21	....do			1, 900	6, 460
James A. Hamilton†	Sch	73. 91	20	....do				
Total		7, 666. 21	933		80	228, 031	132, 939	540, 927

* Tenders to the fleet. † Lost in 1889.

The New Bedford whale fleet rendezvousing at San Francisco in 1889.

Name of vessel.	Rig.	Net tonnage.	No. of crew.	Whaling grounds.	No. of whales taken.	Products landed.		
						Gallons of oil.	Pounds of bone.	Value.
Belvedere	Str	339.37	45	Bering Sea and Arctic Ocean.	3	3,780	3,850	$14,564
William Lewis	Str	332.04	41	do	3	5,513	5,000	19,150
Andrew Hicks	Bark	287.96	37	do	2		3,800	12,920
Lancer	Bark	280.75	36	do	2	4,694	4,205	16,128
Lagoda	Bark	352.59	39	do	1		1,600	5,440
Mars	Bark	243.44	34	do				
William Baylies	Bark	308.83	40	do	1	5,513	5,000	19,150
Jacob A. Howland	Bark	337.40	40	do	4	9,765	6,200	24,888
Josephine	Bark	365.32	37	do	1	1,890	1,400	5,497
Reindeer	Bark	339.62	31	do	3	9,450	7,700	29,866
Alice Knowles	Bark	287.64	35	do	1	1,575	1,300	5,034
Abraham Barker	Bark	361.26	40	do	1	3,938	2,700	10,716
Triton	Bark	251.60	37	do			200	680
Tamerlane	Bark	353.87	33	do	1	2,016	1,700	6,566
Ocean	Bark	274.32	34	do	1	2,835	2,000	7,906
Sea Ranger	Bark	259.46	31	do	2	4,725	3,000	12,043
Lydia	Bark	313.28	38	Okhotsk and Japan Seas.	12½	23,940	7,200	33,817
Cape Horn Pigeon	Bark	201.42	31	do	14½	30,240	10,600	47,834
Charles W. Morgan	Bark	298.06	35	do	6	18,900	6,000	27,771
Alaska	Bark	323.00	29	do	8	31,500	10,000	46,285
Alexander	Brig	128.88	25	Bering Sea and Arctic Ocean.				
Lucretia *a*	Str	275.81	45	do				
Ohio 2d *a*	Bark	344.93	39	do				
Total		6,860.85	832		67	160,274	83,455	346,255

a Lost in 1889.

THE COD FISHERY.

General considerations.—San Francisco is the only port on the Pacific coast of the United States from which this fishery has been prosecuted, and even there its importance has declined materially in recent years. The most prominent causes of decline are (1) lack of demand in domestic or foreign markets;* (2) the keen competition of Eastern producers, who send quantities of Atlantic cod to the west coast; and (3) the tendency for capital to seek investment in the more promising salmon fisheries of Alaska.

Historical review.—The history of the Pacific cod fishery is interesting, and is replete with characteristic examples of the business enterprise of the West, as well as illustrations of the professional skill and indomitable energy for which American fishermen have always been noted. The establishment of this fishery on a commercial basis is a prominent instance of what may be accomplished by seizing upon opportunities that accident has shown to exist. Previous to 1863 all of the salt-cured cod and smoked fish used on the Pacific coast were the products of the Atlantic fisheries, and were brought across the Isthmus or shipped around Cape Horn. The transportation charges

* See discussion of this under head of "Markets, transportation, etc.," page 107.

were high, and the product was often injured or entirely spoiled in passing through the heat of the tropics. Dried cod was, consequently, difficult to obtain on the Pacific coast, and always expensive to the consumer, while dealers frequently suffered severe loss by being compelled to throw consignments of fish into the bay.

In 1857 Capt. Matthew Turner, master of the brig *Timandra*, 120 tons, sailed from San Francisco with an assorted cargo for Nicolaevsk, on the Amoor River. He was detained, however, for three weeks at Castor Bay, at the head of the Gulf of Tartary, because the Amoor River was full of ice when he reached the Asiatic coast. While the vessel lay there waiting, anchored in 3 fathoms of water, the crew began fishing over the rail with hand lines, simply as a pastime. They were surprised to find plenty of cod, averaging about 2 feet in length. Captain Turner had not previously seen codfish, but some of his crew were familiar with the species, and he, knowing their market value at San Francisco, appreciated the importance of the discovery and became interested in the fishing. Two years later Captain Turner made another trip to the Amoor River. Reaching Saghalin Island, off the Gulf of Tartary, he began fishing for cod and found them very abundant. Only enough were taken for ship's use, however, for he was not provided with the means to cure more.

In 1863 Captain Turner once more sailed in the *Timandra* to Amoor River. But this time he went prepared to catch and cure some cod on his return voyage. Besides fishing gear, he carried 25 tons of salt. Returning he stopped to fish at the Gulf of Tartary. Cod were plentiful at first, and 10 tons were taken in a few days, and salted in kench. But suddenly the fish disappeared and none could be caught. Then the brig ran down the coast to southern Kamtchatka, where fish were found in abundance, and excellent success was met with on the first day. The vessel lay near the rocky coast, and on the second day, during the prevalence of a dense fog, both anchors were lost. This mishap compelled Captain Turner to abandon fishing and to leave the coast; he reluctantly sailed for home. His fish sold at San Francisco for 15 cents per pound, and his voyage would have been notably profitable if the loss of anchors had not interfered with obtaining a full fare. This was the first occasion that salt cod were landed on the west coast from Pacific fishing grounds.

In 1864 Captain Turner sailed in his brig on a cod-fishing voyage. Thus the *Timandra* was the first vessel to engage in this industry from Pacific ports. On the same grounds visited the previous year a fare of 100 tons of codfish was obtained, and the voyage was remunerative. The same year the schooner *Alert* made a trip to Bristol Bay, Alaska, in pursuit of cod. Her voyage proved a failure, for she took only 9 tons of fish.

Captain Turner states that since he made his voyages to the Gulf of Tartary, as related above, no American vessels have gone there to fish for cod. His success, however, had a very decided effect upon the cod-

fishing business in the North Pacific, and in 1865 six vessels sailed from San Francisco to the Okhotsk Sea in pursuit of cod. These were the first American vessels to visit that region on cod-fishing trips; and their sailing evidenced a resolution to begin the business upon a broad commercial basis.

But Captain Turner, who seems to have possessed the spirit and enterprise of a pioneer or discoverer, determined to look for cod-fishing grounds nearer home. Not disheartened by the ill success of the *Alert* in 1863, he sailed for Alaska on the schooner *Porpoise*, of 45 tons, March 27, 1865, and arrived at the Shumagin Islands May 1. He began fishing the same day. Cod were abundant and close inshore. As a result, he returned to San Francisco on July 7 with a fare of 30 tons of fish—something less than a full cargo, which might easily have been secured, only for the desire to market the catch in advance of the arrival home of the vessels that had sailed to the fishing grounds on the Asiatic side of the Pacific. This was the first fare of cod from the Shumagin Islands, a locality since famous in the annals of the Pacific cod fishery.*

The cod-fishing fleet of 1864 was composed wholly of rather small-sized schooners, most of which were originally built in New England for the Atlantic fisheries, but had sailed around Cape Horn to find employment in the business of the Occident. It is remarkable that one of those that crossed the Pacific, sailing about 5,000 miles from home, was only 20 tons, a mere boat in which to make such a voyage, and to return loaded "nearly decks to the water." Following are the names and tonnage (in round numbers) of the fleet: *Equity*, 63 tons; *Flying Dart*, 84 tons; *H. L. Ruggles*, 75 tons; *J. D. Sanborn*, 71 tons; *Mary Cleveland*, 91 tons; *Porpoise*, 45 tons, and *Taccon*, 20 tons.

The Okhotsk Sea fleet all secured full fares and returned in safety. The fish were small, averaging only about 3 pounds each when dry. But in those early days they were in demand, and sold for from 12½ to 15 cents per pound, a price that gave remunerative returns and the promise of future success for the fishery. There was no lack of cod, and even with the method of fishing with hand lines over the vessel's side then in vogue no difficulty was experienced in filling moderate-sized schooners in a reasonable time.

During the years succeeding the events narrated the Pacific cod fishery has been subject to many fluctuations, changes in methods, etc., until, in 1889, it employed the smallest fleet that has found occupation in it since the catching of cod became a recognized industry of the west coast. These changes are discussed in detail elsewhere; it is only necessary to say here that among them may be mentioned the employment of larger vessels, the discovery of new fishing grounds where somewhat larger fish can be taken, the establishment of fishing stations

*The statements given above concerning the early history of the Pacific cod fishery were obtained by Wilcox from Captain Turner, to whom we are indebted for many interesting facts not heretofore published.

on shore, and the adoption of the method of dory fishing. Following is a tabulated statement, obtained by Wilcox, of the number of vessels employed each year since 1864, the aggregate tonnage (in round numbers), and the total amount of cured (dry) cod taken, showing at a glance the fluctuation in these elements of the fishery:

Year.	No. of vessels.	Aggregate tonnage	Tons of dried cod.	Year.	No. of vessels.	Aggregate tonnage	Tons of dried cod.
1865	7	449	350	1878	21	2,232	1,984
1866	16	1,689	1,040	1879	10	1,559	2,345
1867	20	2,083	1,572	1880	8	1,597	1,804
1868	10	1,502	1,013	1881	8	1,597	1,591
1869	21	2,669	1,720	1882	13	2,383	1,861
1870	24	3,376	2,109	1883	17	3,260	2,580
1871	16	2,224	1,286	1884	16	3,513	2,433
1872	7	793	500	1885	12	2,347	2,061
1873	12	1,274	916	1886	11	2,418	1,846
1874	8	606	635	1887	8	1,704	1,693
1875	9	847	840	1888	8	1,581	1,580
1876	13	1,387	1,263	1889*	4	941	784
1877	16	2,276	1,250				

* These figures are given by Alexander, and include only the fleet actually engaged in fishing. Besides these the schooner *Czar*, 137 tons, was employed as a tender to the shore fishing stations in Alaska, carrying men and material there in the spring and bringing back the fish taken. She is, therefore, essentially one of the cod fleet. The amount of fish transported by her is given on page 100, and is additional to that stated above. The schooner *Unga*, 19.18 tons, was also employed as a tender, running between shore stations. The combined tonnage is 1,097.68 tons. and the fish aggregate 1,274 tons.

The following statements give the name, rig, tonnage, dates of sailing and return, fishing ground, and number of fish caught for each vessel of the San Francisco cod-fishing fleet from 1880 to 1888:

Name, rig, tonnage, dates of sailing and return, fishing grounds, catch (in number) of fish, etc., of the San Francisco cod-fishing fleet from 1880–88.

Name of vessel.	Rig.	Tonnage (net).	Date of sailing.	Date of return.	Fishing grounds.	No. of fish taken.
1880.						
Alfred Adams			Mar. 16	May 8	Shumagin Islands	42,000
Do			May 17	June 25	...do	52,000
Do			July 3	Aug. 16	...do	45,000
Wild Gazelle	Sch.	108.76	Apr. 8	Aug. 23	...do	87,000
Do	Sch.	114.48	Sept. 11	Oct. 23	...do	62,000
Arago	Sch.	176.50	May 2	Sept. 20	Okhotsk Sea	125,000
Page	Sch.	109.68	May 8	Sept. 4	...do	60,000
Glencoe	Brg.	169.59	May 1	Oct. 28	...do	120,000
Fremont	Bkn.	328.31	May 6	Oct. 10	...do	220,000
Constitution	Bkn.	276.82	May 8	Oct. 28	...do	165,000
San Luis	Bkn.	275.61	May 17	Oct. 4	...do	225,000
						1,203,000
1881.						
Alfred Adams			Mar. 21	May 21	Shumagin Islands	52,000
Do			June 7	July 19	...do	51,000
Do			July 26	Sept. 18	...do	51,000
Wild Gazelle	Sch.	108.76	Apr. 1	Aug. 28	...do	75,000
Page	Sch.	109.68	Apr. 23	Sept. 12	...do	68,000
Arago	Sch.	176.50	Apr. 27	Sept. 11	Okhotsk Sea	90,000
Constitution	Bkn.	276.82	...do	Oct. 17	...do	185,000
Glencoe	Brg.	169.59	Apr. 29	Oct. 15	...do	103,000
Fremont	Bkn.	328.31	Apr. 30	Sept. 18	...do	201,000
San Luis	Bkn.	275.61	May 6	Oct. 15	...do	185,000
						1,061,000
1882.						
Ariel	Sch.	94.35	Mar. 18	Aug. 18	Shumagin Islands	49,000
Wild Gazelle	Sch.	108.76	...do	May 16	...do	60,000
Do	Sch.	108.76	June 2	July 28	...do	83,000
Do	Sch.	108.76	Aug. 12	Oct. 2	...do	60,000

Name, rig, tonnage, dates of sailing and return, fishing grounds, catch (in number) of fish, etc., of the San Francisco cod-fishing fleet from 1880–88—Continued.

Name of vessel.	Rig.	Tonnage (net).	Date of sailing.	Date of return.	Fishing grounds.	No. of fish taken.
1882.						
Page	Sch.	109.68	Mar. 20	Aug. 24	Shumagin Islands	31,000
General Miller	Sch.	108.78	..do	(Lost.)		
H. L. Tiernan	Sch.	142.76	Apr. 5	(Ashore.)	Shumagin Islands	
Dashing Wave	Sch.	141.46	Apr. 29	Sept. 19	....do	60,000
Adrianna	Sch.	95.58	May 8	July 6	....do	54,000
Isabel	Sch.	175.69	May 12	Sept. 1	Bering Sea	50,000
Tropic Bird	Brg.	172.31	Apr. 28	Sept. 25	....do	82,000
Arago	Sch.	176.50	Apr. 15	Sept. 28	Okhotsk Sea	111,000
San Luis	Bkn.	275.61	Apr. 29	Oct. 9	....do	185,000
Glencoe	Brg.	169.59	May 4	Oct. 17	....do	72,000
Fremont	Bkn.	328.31	May 6	Sept. 28	....do	204,000
Constitution	Bkn.	276.82	May 13	Oct. 13	....do	140,000
						1,241,000
1883.						
Wild Gazelle	Sch.	108.76	Mar. 20	June 14	Shumagin Islands	85,000
Do	Sch.	108.76	June 21	Aug. 3	....do	90,000
Do	Sch.	108.76	Aug. 15	(Lost Aug. 19)		
W. H. Stevens	Sch.	139.44	Apr. 21	July 27	Shumagin Islands	77,000
Dashing Wave	Sch.	141.46	May 7	Sept. 21	....do	44,000
John Hancock	Sch.	167.62	Mar. 29	Aug. 22	Bering Sea	75,000
Francis Alice	Sch.	125.26	...do	...do	....do	60,000
Bonanza	Sch.	128.70	Apr. 14	...do	....do	52,000
Tropic bird	Brg.	172.31	Mar. 29	..do	...do	89,000
Isabel	Sch.	175.69	Apr. 2	Sept. 19	...do	105,000
Arago	Sch.	176.50	Apr. 16	Oct. 5	Okhotsk Sea	96,000
Hera	Sch.	369.47	Apr. 20	Oct. 19	....do	188,000
San Luis	Bkn.	275.61	Apr. 24	Oct. 15	....do	150,000
Constitution	Bkn.	276.82	...do	Oct. 6	....do	150,000
Glencoe	Brg.	169.59	Apr. 25	Oct. 27	....do	95,000
Fremont	Bkn.	328.31	Apr. 28	Sept. 19	....do	186,000
Una	Sch.	197.22	Apr. 30	Oct. 3	....do	118,000
Czar	Sch.	137.13	Oct. 3	Nov. 10	Shumagin Islands	60,000
						1,720,000
1884.						
Dashing Wave	Sch.	141.46	Mar. 22	Aug. 25	Bering Sea	85,000
John Hancock	Sch.	167.62	...do	July 27	....do	96,000
Wild Gazelle	Sch.	108.76	Sept. 19	(Lost.)	....do	
Helen W. Almy	Bk.	298.59	Apr. 2	Sept. 5	....do	185,000
Hera	Sch.	369.47	Apr. 9	Oct. 3	Okhotsk Sea	135,000
Arago	Sch.	176.50	Apr. 11	Oct. 7	... do	80,000
Isabel	Sch.	175.69	Apr. 13	Oct. 4	....do	90,000
W. H. Meyer	Brg.	256.50	Apr. 18	Oct. 9	....do	90,000
Tropic Bird	Brg.	172.31	Apr. 20	Oct. 6	....do	82,000
Jane A. Falkenburg	Bkn.	295.10	..do	Oct. 3	....do	136,000
San Luis	Bkn.	275.61	Apr. 26	...do	....do	90,000
Constitution	Bkn.	276.82	...do	Oct. 6	....do	104,000
Fremont	Bkn.	328.31	May 2	Oct. 1	...do	118,000
Glencoe	Brg.	169.59	May 5	Oct. 27	....do	42,000
Francis Alice	Sch.	125.26		Oct. 25		40,000
Czar	Sch.	137.13	Mar. 23	June 14	Bering Sea	102,000
Do	Sch.	137.13	June 25	Aug. 14	....do	97,000
Do	Sch.	137.13	Sept. 16	Nov. 5	....do	50,000
						1,622,000
1885.						
Czar	Sch.	137.13	Mar. 12	Apr. 20	Shumagin Islands	68,000
Do	Sch.	137.13	May 8	June 30	....do	120,000
Do	Sch.	137.13	July 19	Sept. 9	....do	98,000
Arago	Sch.	176.50	Mar. 27	Sept. 11	....do	50,000
Dashing Wave	Sch.	141.46	Apr. 1	June 11	....do	100,000
John Hancock	Sch.	167.62	Apr. 1	Aug. 2	....do	64,000
Isabel	Sch.	175.69	Apr. 18	Aug. 27	... do	85,000
Helen W. Almy	Bk.	298.59	Apr. 18	Sept. 5	Bering Sea	182,000
Constitution	Bkn.	276.82	Apr. 22	Oct. 9	Okhotsk Sea	120,000
Tropic Bird	Brg.	172.31	Apr. 25	Sept. 18	Bering Sea	79,000
Francis Alice	Sch.	125.26	Apr. 28	Aug. 10	Shumagin Islands	35,000
San Luis	Bkn.	275.61	Apr. 30	Oct. 16	Okhotsk Sea	118,000
Fremont	Bkn.	328.31	May 2	Oct. 8	....do	135,000
Jane A. Falkenburg	Bkn.	295.10	May 3	Sept. 25	....do	120,000
						1,374,000

Name, rig, tonnage, dates of sailing and return, fishing grounds, catch (in number) of fish, etc., of the San Francisco cod-fishing fleet from 1880-88—Continued.

Name of vessel.	Rig.	Tonnage (net).	Date of sailing.	Date of return.	Fishing grounds.	No. of fish taken.
1886.						
Czar	Sch.	137.13	Apr. 1	May 24	Shumagin Islands	99,000
Do	Sch.	137.13	June 13	Aug 10	....do	101,000
Do	Sch.	137.13	Aug. 28	Oct. 10	....do	65,000
Isabel	Sch.	175.69	Apr. 1	Aug. 11	....do	92,000
Francis Alice	Sch.	125.26	Apr. 3	July 15	Bering Sea	69,000
John Hancock	Sch.	167.62	Apr. 13	Aug. 6	Shumagin Islands	60,000
Helen W. Almy	Bark	298.59	...do	Sept. 15	Bering Sea	170,000
Fremont	Bkn.	328.31	Apr. 23	Oct. 4	Okhotsk Sea	141,000
Constitution	Bkn	276.82	May 4	Oct. 1	....do	84,000
San Luis	Bkn.	275.61	May 9	Oct. 7	....do	102,000
Jane A. Falkenburg	Bkn.	295.10	May 21	Oct. 5	... do	101,000
Dashing Wave	Sch.	141.46	June 12	Sept. 5	Shumagin Islands	30,000
Do	Sch	141.46	Mar. 14	May 30	... do	38,000
Arago	Sch.	176.50	Jan. 7	Sept. 18	....do	70,000
						1,222,000
1887.						
John Hancock	Sch.	167.62	Mar. 20	July 12	Shumagin Islands	76,000
Isabel	Sch.	175.69	Mar. 26	Aug. 25	....do	80,000
Dashing Wave	Sch.	141.46	Apr. 6	Aug. 29	....do	79,000
Arago	Sch.	176.50	Apr. 24	Sept. 4	....do	76,000
Czar	Sch.	137.13	Apr. 2	May 20	....do	125,000
Do	Sch.	137.13	June 11	Aug. 7	....do	99,000
Do	Sch.	137.13	Aug. 25	Oct. 15	....do	75,000
Constitution	Bkn.	276.82	Apr. 12	Aug. 12	Bering Sea	185,000
Fremont	Bkn.	328.31	May 4	Sept. 19	Okhotsk Sea	170,000
Jane A. Falkenburg	Bkn.	295.10	May 29	Oct. 5	... do	142,000
						1,107,000
1888.						
Czar	Sch.	137.13	Mar. 12	May 14	Shumagin Islands	131,000
Do	Sch.	137.13	June 3	Aug. 8	....do	115,000
Do	Sch.	137.13	Aug. 26	Oct. 31	....do	55,000
Dashing Wave	Sch.	141.46	Mar. 16	July 21	....do	69,000
Arago	Sch.	176.50	Apr. 12	Sept. 2	Bering Sea	103,000
Constitution	Bkn.	276.82	Apr. 25	Aug. 29	... do	191,000
Fremont	Bkn.	328.31	May 1	Sept. 19	Okhotsk Sea	165,000
Jane A. Falkenburg	Bkn.	295.10	May 10	Sept. 23	... do	136,000
Isabel	Sch.	175.69	....	(Lost.)	....	....
Eliza Miller	Sch.	148.53	Aug. 30	Oct. 25	Shumagin Islands	71,000
						1,036,000

San Francisco cod fleet, 1888.

Name of vessel.	Rig.	Net tonnage.	Value.	Value of outfit.	No. of fishermen.	Fishing grounds.	Pounds of codfish landed at San Francisco.	Value.
Fishing.								
Arago	Sch.	176.50	$7,000	$6,500	24	Bering Sea	360,000	$9,010
Constitution	Bkn.	276.82	8,000	10,000	35	....do	668,500	16,900
Dashing Wave	Sch.	141.46	9,000	6,000	21	Shumagin Islands	241,500	6,037
Fremont	Bkn.	328.31	15,000	10,000	40	Okhotsk Sea	660,000	16,500
Isabel*	Sch.	175.69	5,000	6,500	19	Shumagin Islands	....	......
Jane A. Falkenburg	Bkn.	295.10	9,000	10,000	36	Okhotsk Sea	544,000	13,600
Freighting.								
Czar†	Sch.	137.13	10,000	1,500	8	Shumagin Islands	1,116,000	27,900
Eliza Miller‡	Sch.	148.53	8,000	1,600	8	....do	....	......
Unga‡	Sch.	19.18	2,000	700	5	... do	....	......
Total	9	1,698.72	73,000	52,800	196	....	3,590,000	89,947

* Lost, with 14 men. † Three trips. ‡ Tender at station.

Capt. Joshua Slocum says that in 1877, being at the Philippine Islands, he conceived the idea of making a cod-fishing voyage to the Okhotsk Sea and carrying his fish back to the islands. He was in the schooner *Pato*, of about 45 tons register. Sailing from the islands in March, he first went to Hongkong, where supplies were taken on board, thence he proceeded to the Okhotsk via Yokohama. Salt and fishing gear were obtained from vessels met with at the Okhotsk and a cargo of 23,000 fish was soon taken. Before sailing on the return voyage, Captain Slocum concluded to take his fare to Portland, Oregon, which he did. This was, so far as we are informed, the first and only fare of salt cod ever landed at that place. Captain Slocum attended to the curing of the fish himself, treating them in the same manner as Bay of Fundy cod are cured on the coast of Maine. The fish were sold at prices varying from 5 to 12 cents per pound, and the voyage on the whole was a profitable one.

History of a cod-fishing firm.—The following notes, which show in detail the varied experiences of a firm that engaged in the cod fishery in the "early days" and still continues the business, are based on reliable statements of those who participated in the events narrated. They throw much light on the history of the business, and lead to a clearer understanding of it. Although cod fishing was begun in 1864, there were as late as 1866 no suitable arrangements for curing the fish and no sufficient knowledge about handling them. At the start the fishery was only an adjunct to some other business.

The late Thomas W. McCollam is said to have been the first on the Pacific coast to establish on a permanent basis a business devoted exclusively to the fish trade. In 1867 he bought his first cargo of cod, and the next year determined to engage permanently in the trade and to conduct the business on the most approved methods. At the beginning he bought and cured several cargoes of cod at Old Sausalito. But the location was not satisfactory and a new station was established at the mouth of Redwood City Creek, about 30 miles south of San Francisco. Here wharves, storehouses, and flake yards were built sufficient for carrying on the curing business, and 5 acres of land were also devoted to it. He visited New England and purchased the fishing schooners *Rippling Wave*, *Wild Gazelle*, and *Flying Mist*. The first was lost on the passage in Magellan Strait; the others arrived safely and were immediately sent to the Shumagin Islands for cod.

The business appears to have been prudently managed, and prospered. In addition to the fish taken by his own vessels he bought many other cargoes. In 1873 a partner was taken into the business, and the firm was then known as Thomas W. McCollam & Co. In 1874 the schooner *Alfred Adams* was added to the cod-fishing fleet. But the same year the *Flying Mist* went to hunt sea otters off Saghalin Island and the coast of Japan, meeting with marked success. The development of the business called for a change of site for the curing station,

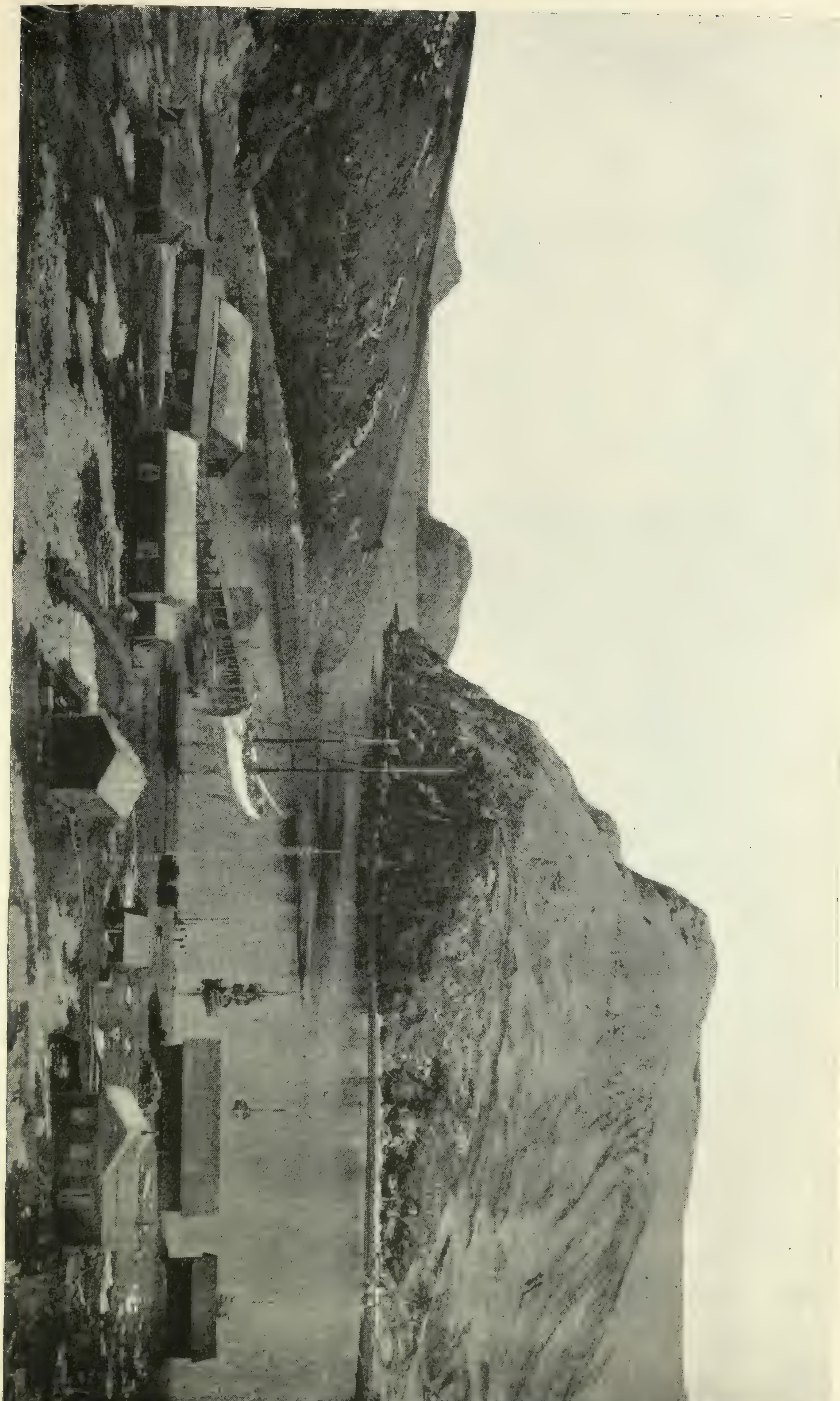
and in 1876 the firm removed to Pescada Landing, opposite Sausalito, on Richardson's Bay, about 5 miles northwest from San Francisco. Here the firm (now the McCollam Fishing and Trading Company) has continued the curing of cod, though it has its office and salesrooms at San Francisco.

The same year that the curing station was established at Pescada Landing it was determined to introduce a new feature in the cod fishery by establishing a station at one of the Shumagin Islands, where fishermen could live in summer, and from which they could pursue cod fishing in boats, salting their catch in storehouses on shore where the fish could remain in kench until it was suitable to send them to market. Pirate Cove, Popoff Island, was selected. The place had already been occupied by a party of hunters, who had resorted here for several years, and had erected a wharf and two buildings. Cod were abundant near the shore, and the fact that the station is still occupied proves the wisdom of its selection. Three schooners were sent to the station the first year, and their crews worked in conjunction with the men on shore.

In 1883 the three-masted schooners *Hera* and *Una* were sent to the Okhotsk Sea, and the brig *Tropic Bird* sailed for Bering Sea. The latter was a new ground for cod, no vessels having previously gone there in search of this species. The vessels were all successful; their catch, together with that obtained by the men at Pirate Cove, amounted to 630,000 fish, or nearly 1,000 tons. In this year (1883) several new members were admitted into the firm and its name was changed to the McCollam Fishing and Trading Company. The fishing fleet was increased by the purchase of the bark *Helen W. Almy* and brig *Tropic Bird* and by building the schooner *Ounimak*. The business at Pirate Cove, which previously had been confined to supplying employés of the firm, was largely increased. A new building was erected at the Cove, and it was stocked with a large amount of goods suitable to the trade, that were forwarded by the schooner *Czar*. This vessel made three trips during the summer, taking salt, fishing gear, and assorted merchandise to Alaska and bringing home codfish and furs.

Additional new buildings and a new wharf were constructed at Pirate Cove in 1884, and the stock of goods was enlarged and improved in variety. This resulted in making the Cove the headquarters for supplies for residents within a radius of 100 miles, and it also induced many of the fishermen to make their homes there, and now, instead of returning to San Francisco at the close of the fishing season, when their term of engagement expires in the fall, they remain to fish or to hunt for fur-bearing animals during the winter.

The system of fishing from shore stations having been found most profitable, the firm gradually withdrew its vessels. The *Hera* was withdrawn in 1885, the *Tropic Bird* in 1886, and the *Helen W. Almy* in 1887. In the latter year a branch fishing station was established at Pauloff Harbor, Sannak Island. In 1888 the schooners *Czar* and *Eliza*



PIRATE COVE, SHUMAGIN ISLANDS, ALASKA.

Miller were employed as tenders to this and the Pirate Cove station, carrying the products to Pescada Landing and returning to Alaska with supplies.

Causes of fluctuations.—The fluctuations and vicissitudes of the Pacific cod fishery are due to several causes. For a long time one of the chief drawbacks was found in the lack of experience on the part of some of those conducting the business. Often they were deficient in the technical skill and knowledge required for properly curing the products landed from their vessels. Firms and individuals that entered into the trade without sufficient knowledge of its requirements soon became discouraged, as a rule, and dropped out of the business; only those with greater skill and more persistence continued the industry. Wilcox pertinently remarks that "those that remain have by long and sometimes by dear-bought experience thoroughly learned all the details of the business and have familiarized themselves with the needs."

Paradoxical as it may seem, for some years a season of exceptional success was often the cause of disaster. Large profits generally created a temporary "boom." Firms or individuals hastened to engage in the fishery. Frequently sufficient care was not exercised in selecting men and vessels. Generally the market was much overstocked at the close of the season. Prices dropped far below the point where they gave remunerative returns to investors. Too often the products could scarcely be sold at any price because of the excess of supply over the demand. The result was necessarily disastrous, and those who had hastened to engage in an enterprise because others had been "lucky" usually abandoned it with the utmost precipitation, leaving the field only to those whose "luck" or experience enabled them to succeed under conditions that ruined or discouraged their competitors. The year 1869 is cited as a fair illustration of the above statements. Serious loss was caused that year by overproduction and improper methods of curing. As a consequence, hundreds of tons of spoiled fish were thrown into the sea. One cargo of 140 tons of cod was brought to San Francisco by a foreign vessel. A duty of one-half a cent per pound was paid on the fish, which, when opened, were in such condition that the whole lot sold for only $500. The fish were shipped around Cape Horn to New York to be used for fertilizing purposes, but arrived in such an offensive condition that they could not be landed; they were taken outside of New York Harbor and thrown into the sea.

The competition arising from the introduction of Atlantic cod in Western markets has possibly had some influence in causing fluctuations in the Pacific cod fishery. But I look upon this rather as the cause of the general decline noticeable in recent years than as a special reason for the variableness alluded to. It is now difficult to predict what may be the ultimate result of this competition, since so many factors are involved, any one of which may have a great influence. The probabil-

ities of counteracting this influence by seeking other markets, etc., are discussed elsewhere.

Present status and importance of the cod fishery.—Compared with former years, when the fleet sometimes numbered upwards of twenty vessels and the products aggregated more than 2,000 tons, the Pacific cod fishery is now unimportant, while it appears at still greater disadvantage if compared with the great cod-fishing industry of the Atlantic States. A particularly unfavorable change in its status took place between 1888 and 1889, as will be seen by reference to the historical notes and tabulated statements given elsewhere. Considered, however, from the standpoint of the needs of the population of the Pacific Slope, the capital invested, the excellent curing stations, and the experience gained, the cod fishery is by no means an unimportant factor in the industries of the far West, and if not abandoned may ultimately attain a status that its present condition gives little reason to hope for.

According to Alexander, "Lynde & Hough were the only firm of San Francisco that had vessels actually engaged in fishing for cod in the season of 1889." They sent the barkentines *Jane A. Falkenburg* and *Fremont* to the Okhotsk Sea (the former sailing May 23 and the latter May 6) and the schooners *Dashing Wave* and *Arago* to Alaskan waters. The barkentines both arrived home on the 25th of September. Their fares aggregated 327,000 fish, equal to 491 tons, valued at $24,550. The combined catch of the two schooners amounted to 195,000 fish, weighing 293 tons, valued at $14,650. These fish were caught about the Shumagin Islands. The *Dashing Wave* landed two fares, the first on June 28 and the second October 8. The firm has a station at Sand Point, Popoff Island, devoted to salmon fishing and outfitting; this is connected with the cod fishery only to the extent that the vessels can, if necessary, land their fares here and refit for another cruise with salt, dories, provisions, etc., which are kept for this purpose as well as for supplying the resident population. This sometimes saves a vessel from making the long trip to San Francisco and back in midsummer, when the fishery is at its height.

During 1889 the McCollam Fishing and Trading Company prosecuted the cod fishery from their shore stations as usual, and had employed the schooner *Unga* (of 20 tons and with a crew of 5 men) as a tender between stations, and the schooner *Czar*, which carried the products to market. The latter made three trips (sailing, respectively, February 11, May 2, and July 10, and arriving home April 16, June 25, and September 1), and brought home an aggregate of 325,000 fish, weighing 490 tons, with a value of $24,500.

The total catch of cod for 1889 amounted to 847,000 fish, weighing 1,274 tons, with a first value of $63,700. The business employed 6 vessels (including 2 used as tenders and freighters), with an aggregate registered tonnage of 1,097.68, and valued at $51,000.

Fishermen, lay, etc.—There have always been a greater or less number

of New England fishermen employed in the Pacific cod fishery since it became a recognized industry. In the early days, when the fishery was most lucrative and important, it was not uncommon for whole crews of trained fishermen to sail for California on schooners purchased at New England ports for the trade. These men were peculiarly fitted to wield an important influence on the industry, for they carried to the Pacific a skill gained by years of experience in the Atlantic fisheries, and hardihood and daring unexcelled. But the business has attracted men of various nationalities, particularly Europeans, and Americans are now, and for several years have been, in a decided minority. Thus, in 1888, out of a crew list of 188, only 30 were Americans, 147 were Scandinavians, 8 were born under the British flag, and 3 were Portuguese. There appears to have been even a greater diversity in 1889. Of 35 fishermen selected at random, Alexander states 9 were Americans, 12 Scandinavians, 6 Portuguese, 4 Russian-Finns, 2 Germans, and 2 Irish.

The system of remuneration differs considerably from that generally adopted on the Atlantic coast, resembling the latter only to the extent that, with few exceptions, the amount earned by each fisherman depends upon the quantity of fish taken by him. Some of the men who have special duties receive a monthly stipend and are sometimes paid, in addition, whatever they can earn by fishing. The captain of a cod-fishing vessel going to the Okhotsk Sea usually receives a stated sum (as agreed upon between him and the owners) per 1,000 fish landed, or he may be hired by the month. The mates, of whom there are generally three on the larger vessels, fish in dories the same as the regular fishermen, and are paid a certain amount per 1,000 for their individual catch, the amount being graded according to their respective official positions, and being considerably more than is paid to the crew. Sometimes they are paid a certain amount per month and the same rate for the fish as the ordinary fishermen get.

The fishermen proper, those who hold no official position and devote themselves exclusively to catching fish while on the banks, receive from $20 to $25 per 1,000 cod for all fish which measure 28 inches in length from tip of snout to end of tail. Cod 26 inches long and upwards, but less than 28 inches, count two for one; those less than 26 inches are not counted. Each man's catch is counted and credited to him as he comes on board, and several trips may be made each day, if fish are plenty, since those who go in the dories have nothing to do with dressing or salting.

On each of the large vessels are eight men, comprising two gangs, whose special duty is to dress and salt the catch. These include two splitters, two throaters, two headers or gutters, and two salters. These men remain on the vessel and receive monthly wages, ranging from $15 to $50 or more, the amount paid depending upon the skill and responsibility of the individual. They also have the privilege of fishing over the vessel's rail when not engaged in other duties. They are paid

the same rates for their catch as the regular fisherman, and occasionally add considerably to their earnings.

Each vessel has a "watchman," who is paid monthly wages, and, like the dressing gang, receives additional pay for fish caught over the vessel's side. On passages his duties are those of a common sailor; but on the fishing banks no anchor watch is kept by other members of the crew, who sleep at stated hours (that can hardly be called night in high northern latitudes), while the watchman remains alone on deck and keeps the lookout. He thus often has exceptional opportunities for fishing, and two instances are cited when watchmen were "high line," having caught more fish than any one else on board.

The vessel furnishes all boats, fishing gear, bait (if any is carried), and provisions free of any expense to the crew. Clothing, tobacco, or other supplies are advanced from the outfitting stores before sailing, or furnished from the "slop-chest" during the voyage, the price of these being deducted from the earnings of each man at the final settlement.

The lay of the Alaskan stations differs slightly from that above described. The fishermen are paid from $25 to $30 per 1,000 for all their fish, but with the understanding that they must dress and salt all their catch. The system of measuring and counting differs only in the size of the fish from that in vogue on the vessels; the fish are salted in the warehouses. It has been given in evidence before the Senate Committee on Relations with Canada that $27.50 is the price paid by the McCollam Fishing and Trading Company, with the understanding that "counts" should be no less than 26 inches in length; those from 24 to 26 inches to be counted two for one, and all less than 24 inches long to be thrown away. Each station is under the control of an agent of the company that operates it, and his relations to the men are the same as those of the captain of a vessel; he superintends their work, keeps the record of their catch, and furnishes them with such supplies as they may need from the company's store. The fishermen live in comfortable quarters on shore and are provided by the company with everything required for fishing, except gear (including trawl lines), which is paid for at a price fixed upon when the men ship for the season. This rule has been adopted to insure greater care for the gear on the part of the fishermen, but it has not been found necessary on vessels fishing at the Okhotsk Sea and Bering Sea, where hand lines only are employed.

On the vessels fishing in Alaskan waters, according to Tanner—

> The captain is paid a stated sum per month, and has no share in the cargo. The mate receives a monthly salary, and also a certain sum for every thousand fish caught. Each of the crew receives $25 per thousand fish; splitters, $50 per month; salters, $40 per month; cooks, $60 per month. On the return from a trip the crew has nothing more to do with the vessel, taking no part in the discharging of the cargo, which is done entirely at the expense of the owners. The cod livers are never saved, and a profitable portion of the fish is thereby thrown away.

I have been told that a system similar to the above has at times been adopted on vessels going to the Okhotsk Sea.

Mention has been made of the fact—an important one so far as the welfare of the men is concerned—that vessels fishing off the coast of Alaska can refit at the shore stations when necessary. Those fishing at the Okhotsk are not so favorably situated; the fishing grounds are 10 to 40 miles from land, usually off the mouths of small rivers or creeks that empty into barred and inaccessible harbors; the vessels must ride out gales or scud away to sea; wood and water are generally procurable, and occasionally some poor beef or a bear may be obtained, but other provisions or supplies are not available on that bleak and barren coast.

Apparatus, methods of capture, bait, etc.—Hand lines are exclusively used in the Okhotsk and Bering Seas, and the system of "dory fishing" is also in vogue. This method is precisely similar to the dory hand-line fishing for cod on the banks of the western Atlantic. A large number of small dories are carried by each vessel, and a single fisherman goes in each boat. Standing in the center of the dory (which is only about 13 feet long on the bottom and a little over 16 feet on top), he throws out a line on each side, and the fish taken are put into the ends of the craft until she is loaded, when they are taken to the vessel and pitched on deck for dressing. The time occupied in loading a dory varies, according to the abundance of fish, from a few hours to a whole day; sometimes only scattering cod can be taken, not enough to half fill a boat, though this is comparatively rare on Pacific fishing grounds.*

It has been found impracticable to set trawls in Bering Sea. The schooner *Constitution* tried to use them in 1887, and the attempt was repeated by the *Arago* in 1888. But no satisfactory results were obtained, because of the great abundance of sea fleas (amphipod crustaceans) on the bottom. These active scavengers not only swarmed upon the bait, but they injured or devoured the cod before the trawls could be hauled.

The hand lines used are similar to those employed in dory hand-line fishing on the Atlantic, but rigged with less care and neatness. Captain Tanner says:

> The fishing leads are made by the crews of the vessels, and therefore do not compare in finish with those of New England. The lines are not tarred, and soon show signs of wear. Patent swivels are apparently unknown; none of the crew of the *Arago* had ever seen or used them; but after the method of working them and their advantages had been explained the fishermen expressed their intention of giving them a trial next year. The dories correspond in shape and size with those used upon the eastern coast, the only perceptible difference being that the stem, timbers, and planking are a trifle heavier. They are manufactured in San Francisco by Lynde & Hough. Galvanized-iron rowlocks are used instead of thole-pins.

Shore cod fishing is wholly carried on in dories, this method bringing the best returns for the money invested. It would be impracticable to

* Captain Slocum says that even the inexperienced men he had on the *Pato*, none of whom had previously seen a codfish, easily caught an average of 500 fish per day (earning $12.50) when the fishing was best.

use vessels in this fishery as the cod feed and school so close to the harbors and coast that dories can make several trips daily to the fishing grounds. This method is successfully followed throughout the year, and in 1889 gave employment to 33 men. The winter catch is salted in kench, in the warehouses, and held there until spring, when the freighter arrives to carry the fish to market.

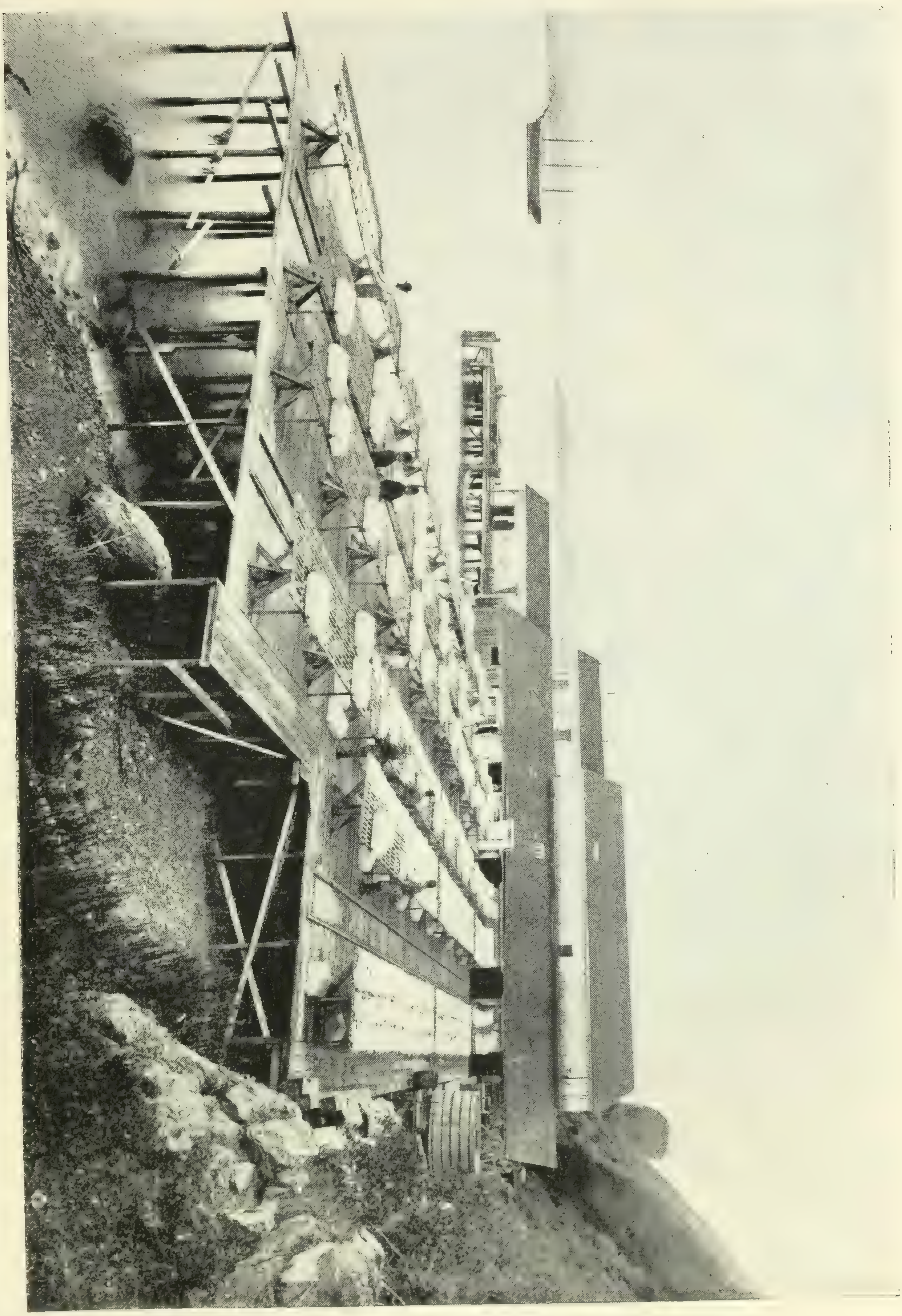
Both trawls and hand lines are used, the former more extensively. The trawls are like those used in the Atlantic cod fishery. The natives at Unalaska have the ordinary type of steel hook for cod fishing, though they still prefer the wooden hooks made by themselves for halibut fishing. Crude and primitive as these hooks are, I am assured by competent authority that they are very effective in catching halibut. Any available material serves the natives as a line for cod fishing. It may be only pieces of old cord knotted together, or a piece of sail or salmon twine, but sometimes cod line is used. Small iron bolts, spikes, or pieces of lead are preferred for sinkers, but stones also serve for this purpose.

Writing of the fisheries at Pirate Cove, which may be taken as fairly representative of all the Alaskan stations, Captain Tanner remarks:

Cod fishing is now carried on in the vicinity of this harbor almost exclusively by means of dories, only one vessel having been engaged here in actual fishing during the present season. Most of the schooners had been sold, and those retained are used for freighting. The grounds resorted to are all within a short distance of the harbor, where dories are more convenient than larger craft. Trawls are chiefly employed, and during good weather they are hauled two and three times a day, but the fish are not dressed until the last haul for the day has been made. Cod fishing continues throughout the year. In summer, when the salmon are running, cod are not abundant, but they reappear in incredible numbers as soon as the salmon leave. During the winter strong southeasterly gales may prevent the hauling of the trawls for a number of days at a time, but there is no period of the year when they can not be used at least several times a week. This is in marked contrast with the climate of the Grand and Western Banks, off the Atlantic coast, some ten degrees farther south, where the fishing vessels are often compelled to lie to for a week, and sometimes for a fortnight, with their dories lashed upon the deck.

Salmon are extensively used for bait, particularly in the Okhotsk Sea. But halibut, herring, sculpins, flounders, and clams are employed for this purpose and answer well, though less attractive than salmon.* According to Dr. Bean the Alaska pollock "is one of the best baits known for cod." He also says that the Atka mackerel (*Pleurogrammus monopterygius*) possesses rare worth as a bait for cod, while the cusk, a species still rare in museums, forms an element in the bait supply for cod at the Shumagins. He also mentions the lant (*Ammodytes personatus*), which is extremely abundant in most parts of Alaska, and the capelin (*Mallotus villosus*), which is universal and abundant throughout the territory, as very important factors in the bait supply for the cod

* Those fishing in Bering Sea usually take a few herring to begin with, after which halibut are exclusively used for bait.



CODFISH FLAKE YARD AND CURING STATION, PESCADA LANDING.

fishery of that region. The herring (*Clupea mirabilis*) is "invaluable as bait."*

The Okhotsk Sea fishermen take salmon for bait when they first appear by trolling. But when the fish enter the rivers the vessels must from time to time go inshore and anchor near the mouths of the streams so that their crews can enter to obtain a supply of salmon for bait.† Often, however, when the vessels lay within a reasonable distance of the land (6 to 10 miles off) they do not get under way, but send a dory, with a party of 4 or 5 men, to the land to seek the bait. One or more large dories are generally carried for this purpose, and a small seine (20 to 30 fathoms in length) is a necessary adjunct of a cod fishing vessel in these waters. Sometimes, but more rarely, salmon may be caught for bait in a gill net set from the vessel's stern on the fishing ground.

Captain Slocum tells me that salmon usually appear in the rivers entering the Okhotsk about the first of July. There are three runs of fish. The humpback salmon enter the rivers first; they are followed some time later by the red salmon, and the silver salmon come last. This refers only to the rivers where salmon are taken by the cod fishermen.

Curing stations and preparation of products.—The two curing stations on San Francisco Bay deserve mention. Pescada Landing is situated along the water, at the foot of a steep hill, on the east side of Richardson's Bay. The plant includes wharves, fish houses, flake yards, quarters for the employés, etc. The main building is two stories, 100 by 220 feet ground plan; the cook house (which includes mess room), 18 by 32 feet; lodging house or dormitory for employés, 16 by 30 feet. Besides these there are several other storehouses, sheds, etc., that afford additional accommodation. There are two flake yards; one is 50 by 150 feet, and the other is 45 by 140 feet. The flakes are like those used in New England. The buildings and flakes are all located over the water and built on piling.

A tank with a capacity of 5,000 gallons is filled with water by a windmill, and the water is carried through pipes by gravitation to all parts of the buildings, thus saving much labor in washing fish, etc. The ground floor of the main building is occupied by large, square, wooden tanks, in which the cod are resalted and are kept in pickle until taken out to be dried. Most of the tanks are each 14 feet long, 7 feet wide, and 6 feet deep. Each holds about 12 tons of fish, but there are also smaller tanks, suited to the place they occupy. The tanks are built of 3-inch plank, and the seams are tightly calked to prevent leaking.

---

* The Fishery Resources and Fishing Grounds of Alaska, by Tarleton H. Bean, Section III, Fisheries and Fishery Industries of the United States, pages 81, 82, and 85.

† The rivers in which salmon are taken for bait are known to the fishermen as Little River, Galigan River, and Great River. Cod fishermen seldom go north of the last-named river; they most commonly fish off Little River.

The specially noteworthy feature of the establishment is a system of tramways extending to all parts of the warehouses and flake yards, upon which run platform cars, each carrying from $2\frac{1}{2}$ to 3 tons of fish at a time. The cars can be moved very easily, and the direction can be changed by means of turn-tables. Their use affords a quick and economical method of handling large quantities of fish in a short time. It is a decided improvement over the primitive wheelbarrow and hand-barrow, still unaccountably in general favor on the Atlantic coast.

When a vessel arrives with a cargo of cod she is moored across the end of the wharf and the fish are loaded on the cars. As fast as the cars are filled they are run upon a platform scale, where the weight of fish is noted, and then off to the washing pond or pickling tanks. At other times the cars carry the fish from the tanks to the flake yards, or thence to the packing or skinning rooms.

The manufacture of boneless fish is carried on in the same manner as in the East, and the product is packed in cases and boxes holding 30, 40, 50, and 100 pounds each. The 40-pound boxes are filled with 2-pound packages of boneless cod, known to the trade as "bricks." Unskinned dried cod are sold in 50-pound bundles. The sloop *Star* carries the prepared products to San Francisco and brings to the station such supplies as are needed.

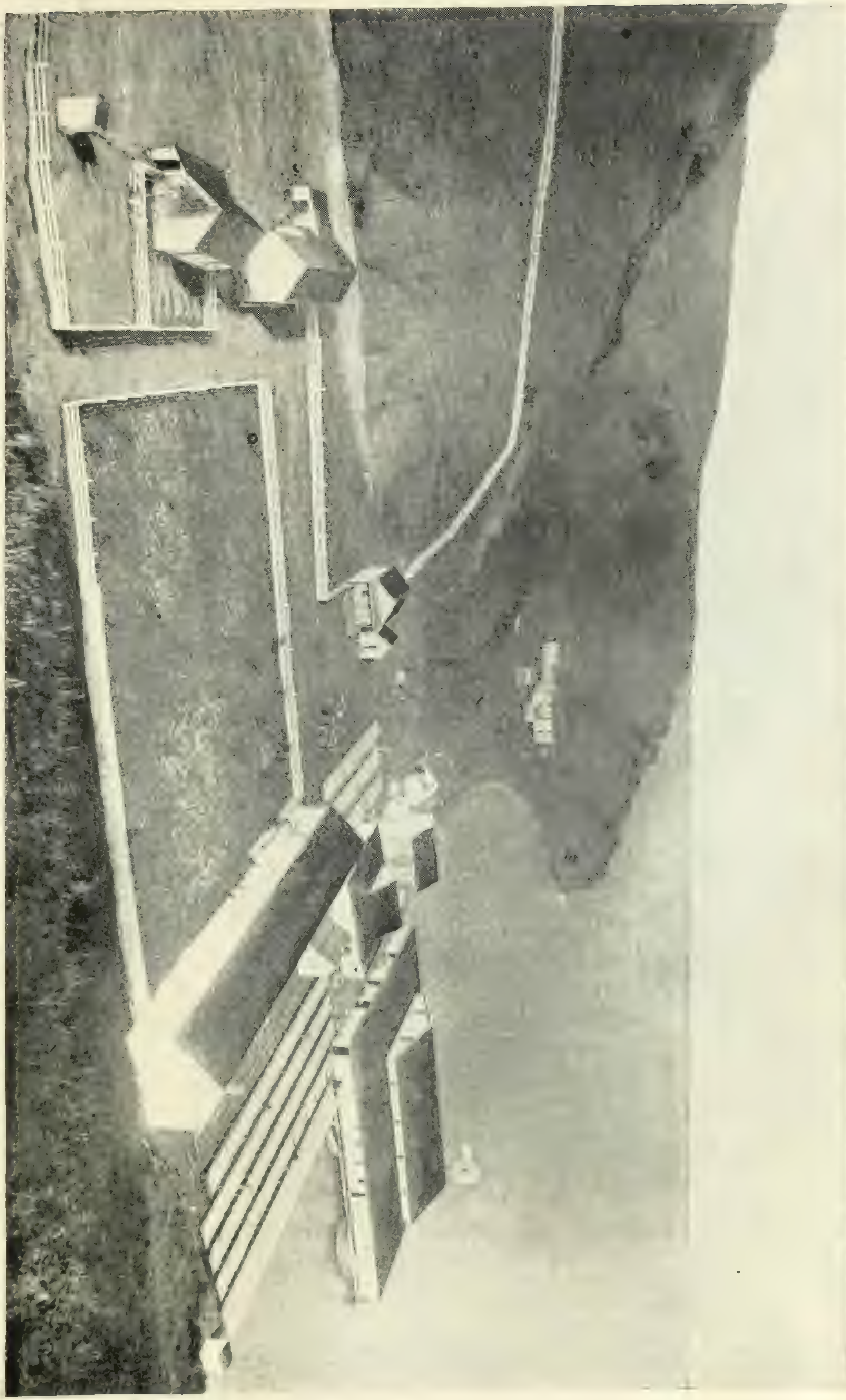
On the second floor of the main building is a sail loft and boat-building shop. Here sails are made or repaired and dories are built.

From 30 to 65 men are employed here in preparing fish for market. All board at the station and eat and sleep in the buildings constructed for those purposes.

The outfitting and curing station, called California City, is very complete, and one of the most remarkable in the country, since it is a settlement composed exclusively of men, not a woman or child living on the premises. It was established by the fishing firm of Lynde & Hough in 1872, and is located on the west side of the bay, nearly opposite Point Richmond, and about 8 miles north of San Francisco. It embraces 50 acres within its limits, most of which is a small and rather flat valley bordering the bay, with hills and steep mountains on its flanks and rear. A pile wharf, at which vessels can discharge their cargoes and refit, is almost wholly covered by an oblong two-story building and the large, low, sloping-roofed sheds that flank it. This storehouse (for sheds and all are part of one structure) has a capacity for 1,200 tons of salted fish, that amount having actually been there at one time, stored in the pickling tanks and casks. Each of the 36 tanks holds 15 tons of fish. They are made of 3-inch redwood plank, dovetailed at the ends. No iron bolts or nails are used in their construction, because rust would injure the fish. Besides tanks, many large casks or butts are used for pickling fish. On the upper floor of the main building are the sail loft and storage rooms for dories, fishing gear, etc.

There are several other buildings besides the receiving house on the

PLATE XIV.



CALIFORNIA CITY. CURING AND OUTFITTING STATION.

wharf, and there is thus ample room for the preparation of boneless fish, smoking herring or other species, mess room, etc., and for the accommodation of the employés, including a house for the overseer. The two flake yards have a capacity for spreading 9 tons of cod. Salt water for pickling purposes is supplied by a windmill pump on the wharf. Fresh water is obtained from springs on Tiburan Mountain, at the rear of the station. This is brought into a reservoir on the side of the mountain, 180 feet above the wharf, and is distributed thence by pipes that carry the water into the buildings and through the yards. The reservoir has a capacity of 1,500,000 gallons.

The station is provided with the means of furnishing itself with provisions to a considerable extent. A garden yields various kinds of vegetables; 8 cows furnish milk and butter; 150 hens provide eggs and poultry; from the piggery comes fresh and salt pork; grapes can be gathered from the vineyard on the hillside, while all is supplemented by a well-kept flower garden. The buildings and fences are neat and tidy in appearance, and as white as paint and whitewash can make them.

From 30 to 75 men are employed here throughout the year. They are paid monthly salaries and provided with board and lodging. A sailing packet plies between San Francisco and California City, making almost daily trips, carrying such products and supplies as the business may demand at either place.

The production of oil and curing of sounds (swim bladders of cod) do not assume the same importance on the Pacific as on the Atlantic coast. Alexander states:

Livers and sounds of Alaskan and Okhotsk Sea cod are not considered of much value. The livers could no doubt be used to some commercial advantage, but the fishermen do not seem disposed to bother with what they consider of minor importance. The sound of the Pacific cod differs greatly from that of the Atlantic species. That of the former is very dark, small, and exceedingly thin, and contains little gelatinous substance.

No effort is made to save sounds or livers at Alaska shore stations.

There have been a few attempts (according to Alexander) made to cure fish at the Alaska stations, and some seasons the weather for a short time is suitable for drying, but it can not be relied upon. In view of this fact it would seem that artificial drying machines could be used to good advantage at all the fishing localities of Alaska, and instead of shipping green fish to San Francisco they could be landed ready for boxing and distributing over the country. Such apparatus would be expensive, and probably the demand for Alaskan cod is not at present sufficiently large to induce those engaged in this fishery to risk any large sum in such an enterprise. In years to come, no doubt, the process of artificially drying fish will be looked upon with more favor than at present.

Markets, transportation, etc.—The decline in the Pacific cod fishery is due to a lack of adequate demand or markets; there is unquestionably

no deficiency of supply; the fishing grounds are believed capable of furnishing an unlimited amount of cod. It is apparent that no lack of skill in catching or curing the fish militates against their sale. So far as domestic markets are concerned, the Pacific cod is at a disadvantage because of its small size and comparative thinness.* Americans usually prefer large thick cod that are white in flesh when cured. The cod from the western Atlantic banks excel in these particulars, and consequently force smaller or thinner fish out of the market. The result has been the absolute abandonment of the Labrador fishery by American fishermen, since the small cod taken there (which are very similar to the Pacific cod) met with so little demand that the last voyages, made more than a decade ago, were decidedly unprofitable.

Previous to the establishment of railroads to the Pacific, the fish-dealers of that region could defy competition; but with the present facilities for transportation the only advantage the Pacific cod has over its Atlantic competitor is the difference in freight charges to reach the consumer. Nevertheless, it is said that eastern fish are placed upon the market, even in San Francisco, "at a figure which seemingly defies competition." A careful observer thinks that the demand for Atlantic cod, in preference to those caught in the Pacific, may, perhaps, be to some extent due to an indisposition on the part of the San Francisco dealers to force their goods upon the interior of the country. "In the early days of California," he says, "the consumer sought the producer; but that day is past. The New England fish-dealer, a quarter of a century ago, could sit in his office and receive by mail enough orders for fish to satisfy his most ardent wishes; but to-day, in order to procure a fair share of trade, he is compelled to employ men at large salaries to canvass the entire country. If the Pacific dealer would compete with his Eastern neighbor he must use the same means and adopt a like method."

It has been suggested that fish may be artificially dried in Alaska, at the stations where they are caught. This is undoubtedly feasible and seems to offer a solution of an otherwise difficult problem, the maintenance of the Pacific cod fishery. It is reasonable to assume that light-salted hard-cured cod might find a ready sale among the fish-eating populations of Mexico and the countries of western South America. These are easier to reach from California than from Atlantic ports, and for this trade small cod would doubtless be preferable. As a matter of fact, very small fish of the Newfoundland catch, if properly cured, bring a high price and meet with readiest sale in Brazil. If this trade could be once established, so that western South Americans could know where to look for supplies of dried fish, there seems no reason to sup-

* The average seldom exceeds 3 pounds for cured fish. The standard of excellence can not be gauged by size alone; in some markets small cod are preferred. It is a noteworthy fact that the cheaper grades of the *Gadidæ*, such as hake, haddock, and cusk, do not occur in the Pacific as in the Atlantic. Cod alone are caught and cured in this industry.

pose that it would be disturbed by competition, for the boundless resources of the Northern Pacific in supplying the material, the suitableness of the cod to this market, and the fact that fish can be taken so near the shore, appear to afford advantages not found elsewhere. It may take time to develop the trade, but its apparent ultimate results warrant the attempt. There is seemingly no reason why the fish could not be successfully shipped in sailing vessels (always a cheap method of transportation), as they are still sent to South American countries from Canada and Newfoundland.

Captain Slocum tells me that there is a good market at the Philippine Islands for a limited amount of hard-dried cod, each weighing from 2 to 2½ pounds and packed in tins or tin-lined boxes holding about 25 pounds. He suggests that the packages should be attractive in appearance and neatly labeled in Spanish. Undoubtedly hard-dried boneless cod, packed in "bricks" of 1 to 3 pounds each, may meet with great favor as soon as the people become familiar with fish packed in that way. In 1876 Captain Slocum found the wholesale price of Norway cod at the Philippines to be 12½ cents (or a real) per pound. At that figure only the wealthy people could afford to eat *bacaloa*, but he thinks large quantities would be used by those of limited means if the fish could be sold at a somewhat lower price.

Possibly many people along the Pacific slope might prefer cod prepared as *laberdan* (put up in pickle in barrels) to the dried article. I am not informed whether any attempt has ever been made to introduce this style of curing, for which the Pacific cod are well adapted. If not, its introduction may open new markets. Fish cured in this manner can not, however, usually be safely transported across the tropics, because the pickle sours in the excessive heat. But for ordinary temperatures it keeps well, particularly if a small amount of "preservative" or boracic acid is used with the salt.

THE FUR-SEAL INDUSTRY.*

Importance, etc.—San Francisco is practically the headquarters of the world for the prosecution of the fur-seal industry, which may be fairly considered one of the most important commercial enterprises of the west coast. The Alaska Commercial Company has the privilege, by lease from the United States, to take from the Pribilof Islands, in Bering Sea, 100,000 fur-seal skins annually.† The same corporation is the agent

*For details of the fur-seal industry see "The Seal Islands of Alaska" (4to), by Henry W. Elliott; "The Fur-Seal Industry of the Pribylof Islands," Alaska, by the same author; and "The Fur-Seal Industry of Cape Flattery, Washington Territory," by James G. Swan. The two latter papers with others relating to the Antarctic fur-seal industry, the sea-otter hunting, etc., may be found on pages 320 to 491, of "Fisheries and Fishery Industries of the United States," section V, volume 2. The paper by Swan relates more particularly to the pelagic sealing from Cape Flattery.

†The term of the lease, which covers twenty years, expired May 1, 1890.

of the lessees of the fur-seal fisheries of the Commander Islands (in the western part of Bering Sea), which belong to Russia, and from this source between 35,000 and 45,000 (occasionally more) pelts are obtained each season and brought to San Francisco.

In addition to the important operations of the above-named company, no less than twelve sail of schooners, ranging from about 19 to 93 tons each, were employed from San Francisco in 1888 in pelagic fur-sealing and hunting sea otters, walrus, etc. Their principal business was capturing fur seals. These vessels secured 4,455 seal pelages during the season. The sum total of the fur-seal industry of San Francisco exceeded $1,576,000 in 1888.

Season, etc.—The vessels generally start on a sealing cruise about the middle of January, and the season closes in September or October, at which time they return. They first look for seals off the Golden Gate, but the hunt does not really begin, as a rule, until the vessels are off the Strait of Fuca, and from there they gradually cruise north, following the migratory movements of the herds until they enter Bering Sea. During the summer the vessels frequently engage in hunting walrus and sea otters, to pass away the time until the seals start south again.

Boats.—The boats carried on the sailing vessels are sharp at both ends and similar to whaleboats (indeed some of them are whaleboats) but generally they are smaller; they cost $90 apiece.

Apparatus, methods of capture, etc.—The apparatus used on the islands consists simply of a club for killing and a knife for flaying the seals, unless we include the bones, etc., used for frightening the animals when they are being driven to the "killing ground." On the Pribilof Group only young "bachelor" seals, preferably 3 to 4 years old, are killed for their furs; a few younger seals are slaughtered for food by the Aleuts, this being permitted by the Government. The "holluschickie" usually gather by themselves on the rookeries. The natives select a drove from the herd, and by making noises or otherwise frightening the seals they drive them near the village or to some suitable killing-ground elsewhere, where the animals are knocked on the head, skinned, and the pelts are salted down in kench in a storehouse. Later they are tied in bundles and shipped to San Francisco on the company's steamer *St. Paul.* The driving and killing goes on from day to day during the "season" until the requisite number of skins have been secured.

Rifles and shotguns are chiefly, if not exclusively, used on the open-water sealing vessels, and generally a large quantity of fixed ammunition is carried. In 1886 the revenue cutter *Corwin* took 4 rifles and 1,100 rounds of fixed ammunition from the sealing vessel *Sierra*, and 6 rifles and 500 rounds of ammunition from the *City of San Diego.*

In hunting seals, 3 men go in each boat, but 4 go in a boat for sea otter. The men go out in boats and shoot the seals as they appear at the surface. When one is shot the boat is rowed swiftly toward it, and, if practicable, it is secured; gaffs are often used for this. It is claimed by those familiar

with this method, that only a small percentage of the slaughtered seals is secured. Some believe that not more than one in ten is saved, while others think it may be one in four or five. No distinction as to age or sex is made in pelagic sealing; consequently the destruction is great, and its effect on the rookeries is vastly disproportionate to the number of skins obtained. The pelts are salted in the holds of the schooners and kept in kench until the port of discharge is reached; sometimes the skins are sent to market on a "tender" that meets the sealing fleet at some rendezvous for this purpose.

Sea otters are also shot and their valuable skins are very carefully handled.

The only parts of the walrus saved are the hide, tusks, and "whiskers." The hides sometimes weigh as much as 500 pounds apiece, and average about 350 pounds; they sell at 10 cents per pound. Tusks average 7 pounds each; the price is usually 55 cents per pound; they are mostly exported to China, where the bristles are also sent; the latter are used for toothpicks by the wealthy Chinese, and are also mounted with gold and utilized for hairpins by the women of China.

Lay, wages, etc.—Elliot has so fully discussed the system of wages, etc., on the Pribilof Islands, that I will not consider the matter here. The sealing vessels furnish all arms, outfits, and equipment of every kind, including salt, and the men ship on wages or on a lay. If wages are paid, the cook and hunters each receive $50 per month, while the others are paid $30 per month. By the lay system the master receives $\frac{1}{10}$, the mate $\frac{1}{40}$, and the seamen from $\frac{1}{80}$ to $\frac{1}{100}$. The average share is usually small. In 1888 it varied from $30 to $200 for the season.

Statistics.—According to the report (H. Rep. 3883, Fiftieth Congress first session) of George R. Tingle, United States Treasury agent, at the seal islands of Alaska, the number of fur seals killed on the islands of St. Paul and St. George for the year ending July 31, 1888, was 103,920, classified as follows:

Items.	Number.
Young pups for native food	3,533
For native food during the stagy season when the skin is not merchantable	309
Small young seals killed by natives during food killing	60
Small young seals killed by the Alaska Commercial Company through accident while taking their catch	18
Alaska Commercial Company under contract	100,000
Total	103,920

It will be seen that the full quota of 100,000 skins was obtained at the Pribilof Islands. Add to this the catch of the San Francisco sealers and we have 104,455 pelts as a result of this branch of the American fishery prosecuted from San Francisco. It seems proper to mention in this connection the products received from the Commander Islands, since the fishery there was controlled by American capital. The Russian

steamer *Alexander*, which arrived at San Francisco October 12, 1888, brought from the Russian Islands 39,348 skins of fur seals, besides other furs. The entire product received from the Commander Islands in 1888 was 47,362 seal skins.* The total number of fur-seal pelages received at San Francisco during the season of 1888 amounted, therefore, to 151,817, worth, at the low estimate of $10 each, $1,518,170.†

SEA-OTTER HUNTING.

Although the pursuit of the sea otter (*Enhydra marina*) is carried on almost exclusively in Alaskan waters, the business is controlled by San Francisco capitalists, who send out vessels and employ natives to hunt. The industry therefore deserves mention here, and available statistics should be presented.

Recently there has been a decided decrease in the numbers of the sea otter, but the pelage is so valuable (exceeding all others in intrinsic worth)‡ that its pursuit employs a considerable amount of capital and many men at certain seasons of the year. The business is an important one for several months, and is relied upon by some of the Aleuts as one of their principal sources of income. It is difficult to present complete statistics of this branch of the fishery, since the investigation upon which this review is based did not cover the region where the fishery is prosecuted, and for that reason the data relating to boats and men employed are not at hand. Vessels engaged in the sea-otter hunt during fall and winter may at other times be utilized as freighters to visit different stations or else be employed in the salmon fishery.

The total number of sea-otter skins received at San Francisco, as reported by competent authority, amounted in 1888 to 2,510, large and small, and 161 cubs, with an aggregate value of $218,625. In 1889 there were 1,901 skins (including 70 cubs), with a value of $164,775. These figures include 125 skins, valued at $9,375, that were taken on other parts of the coast, and which can not be included under the head of San Francisco products.

Fishing grounds.—The principal localities for the capture of the sea otter are about the reefs and outlying islets of the Aleutian chain of islands. Sannak and vicinity is a favorite hunting ground. Sometimes the kalan is taken in the water, but in heavy storms and gales it is frequently surprised and killed when asleep on the shores or projecting reefs of the islands. Sea otters are also taken occasionally in the vicinity of Cape Flattery or the Strait of Fuca.

---

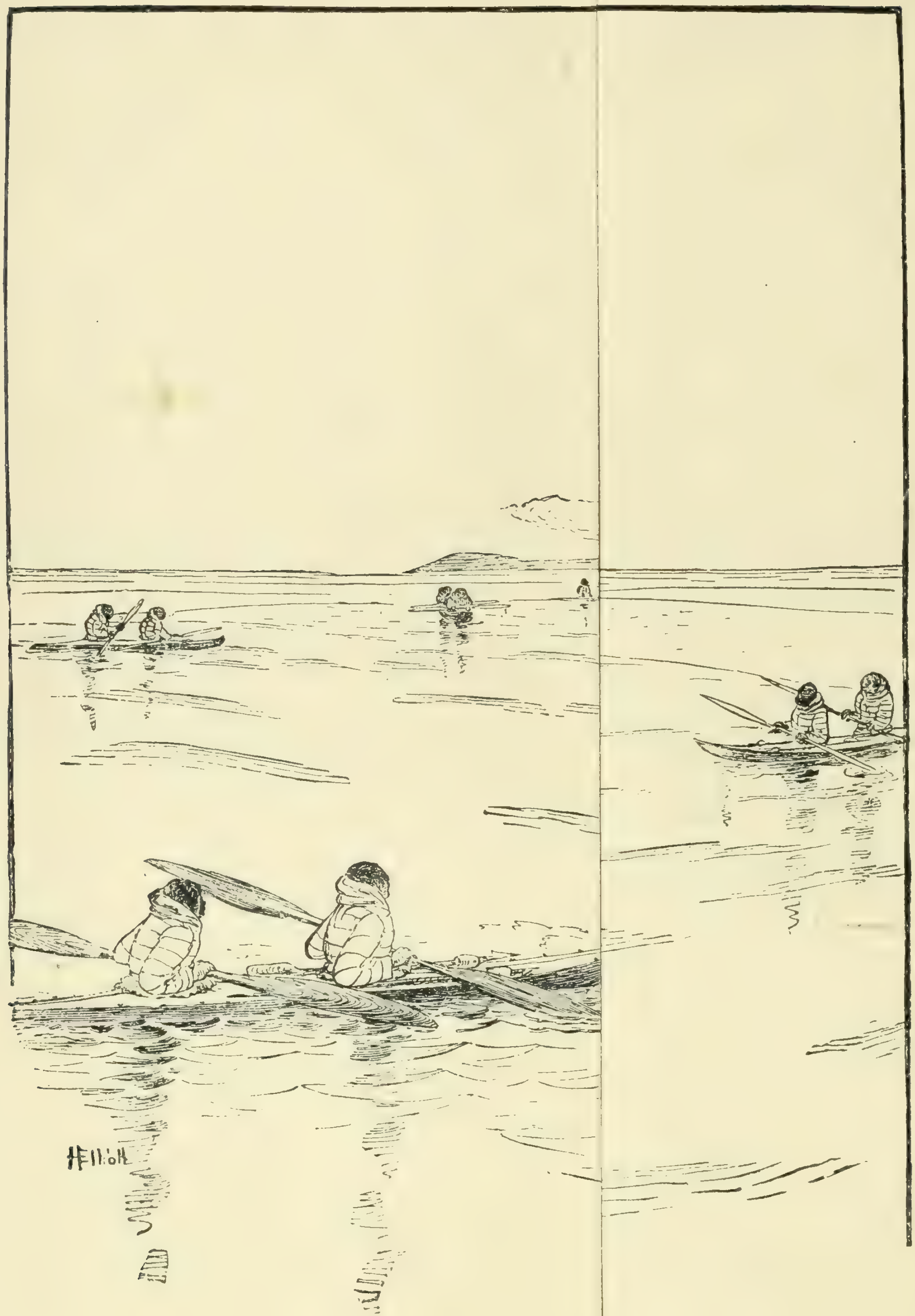
* In 1889 this amount was increased to 52,700, and in 1890 52,000 pelts were received.

† In 1888 and 1889 Alaskan fur-seal skins were worth from $15 to $16 in the London market, while those from the Commander Islands sold for from $11 to $12. The skins are not sold in San Francisco, but the estimate given above is about what they would have brought there had they been put on the market.

‡ In *Land and Water* of August 30, 1890, it was stated that the price of the best pelage of sea otter was from $100 to $300; medium, $50 to $85; brownish, $10 to $25.

SEA-OTTER HUNT. A "SURROUND.

(Drawn by Henry W. Elliott.)


HElliott

Boats.—The best boat for otter hunting is the two-hole skin bidarka; no other is used by the Aleuts. White men naturally prefer light-built, swift-rowing wooden boats, but they seldom engage personally in hunting this animal, as the life training and inherited habits of the native specially fit him for the work.

Apparatus and methods of capture.—Clubs, spears, and rifles are used for effecting the capture. The two former are the native weapons and until recently have been generally preferred by the Aleuts, because they could be used without noise; but lately the white traders have encouraged the use of rifles, and these have largely superseded the primitive weapons of the natives.

Elliott makes the following interesting remarks concerning the sea otter, and the methods pursued in hunting it:

The subtle acumen displayed by the sea otter in the selection of its habitat can only be fully appreciated by him who has visited the chosen land, reefs, and water of its resort. It is a region so gloomy, so pitilessly beaten by wind and waves, by sleet, rain, and persistent fog, that the good Bishop Veniaminov, when he first came among the natives of the Aleutian Islands, ordered the curriculum of hell to be omitted from the church breviary, saying as he did so that these people had enough of it here on this earth! The fury of hurricane gales, the vagaries of swift and intricate currents in and out of the passages, the eccentricities of the barometer, the blackness of the fog, enveloping all in its dark, damp shroud, so alarm and discomfit the white man that he willingly gives up the entire chase of the sea otter to that brown-skinned Aleut who alone seems to be so constituted as to dare and wrestle with these obstacles through descent from his hardy ancestors, who in turn have been centuries before him engaged just as he is to-day.

So we find the sea-otter hunting of the present, as it was in the past, entirely confined to the natives, with white traders here and there vying in active competition one with the other in bidding for the quarry of those dusky captors. The traders erect small frame dwellings as stores in the midst of otter-hunting settlements, places like Unalaska, Belcovsky, Unga, and Kadiak villages, which are the chief resorts of population and this trade in Alaska. They own and employ small schooners, between 30 and 100 tons burden, in conveying the hunting parties to and from these hamlets above mentioned, as they go to and return from the sea-otter hunting grounds of Sannak and the Chernabura Rocks, where five-sixths of all the sea otters annually taken in Alaska are secured. Why these animals should evince so much partiality for this region between the Straits of Unimak and the west end of Kadiak Island is somewhat mysterious, but, nevertheless, it is the great sea-otter hunting-ground of the country. Sannak Island, itself, is small, with a coast circuit of less than 18 miles. Spots of sand beach are found here and there, but the major portion of the shore is composed of enormous water-worn bowlders, piled up high by the booming surf. The interior is low and rolling, with a central ridge rising into three hills, the middle one some 800 feet high. There is no timber here, but an abundant exhibit of grasses, mosses, and sphagnum, with a score of little fresh-water ponds, in which multitudes of ducks and geese are found every spring and fall. The natives do not live upon the island because the making of fires and scattering of food-refuse, and other numerous objectionable matters connected with their settlement, alarm the otters and drive them off to parts unknown. Thus the island is only camped upon by the hunting squads, and fires are never made unless the wind is from the southward, since no sea otters are ever found to the northward of the ground. The sufferings, miseries of cold, and even hunger, to which the Aleuts subject themselves here every winter, going for weeks and weeks at a time without fires, even for cooking, with

the thermometer below zero in a wild, northerly and westerly gale of wind, is better imagined than portrayed.

To the southward and westward of Sannak, stretching directly from it out to sea 8 or 10 miles, is a succession of small, submerged islets, rocky and bare, most of them, at low water, with numerous reefs and stony shoals, beds of kelp, etc. This scant area is the chief resort of the kalan, together with the Chernabura Islets, some 30 miles to the eastward, which are identical in character. The otter rarely lands upon the main island, but he is, when found ashore, surprised just out of the surf-wash on the reef. The quick hearing and acute smell possessed by this wary brute are not equaled by any other creatures in the sea or on land. They will take alarm and leave instantly from rest in a large section, over the effect of a small fire as far away as 4 or 5 miles distant to the windward of them. The footsteps of man must be washed from a beach by many tides before its trace ceases to scare the animal and drive it from landing there, should it approach for that purpose.

The fashion of capturing the sea otter is ordered entirely by the weather. If it be quiet and moderately calm to calm, such an interval is employed in "spearing surrounds." Then, when heavy weather ensues, to gales, "surf-shooting" is the method; and if a furious gale has been blowing hard for several days without cessation, as it lightens up, the hardiest hunters "club" the kalan. Let us first follow a spearing party; let us start with the hunters and go with them to the death.

Our point of departure is Unalaska village; the time is an early June morning. The creaking of the tackle on the little schooner out in the bay as her sails are being set and her anchor hoisted causes a swarm of Aleuts, in their bidarkas, to start out from the beach for her deck. They clamber on board and draw their cockle-shell craft up after them, and these are soon stowed and lashed tightly to the vessel's deck-rail and stanchions. The trader has arranged this trip and start this morning for Sannak by beginning to talk it over two weeks ago with these 30 or 40 hunters of the village. He is to carry them down to the favored otter-resort, leave them there, and return to bring them back in just three months from the day of their departure this morning. For this great accommodation the Aleuts interested agreed to give the trader-skipper a refusal of their entire catch of otter skins—indeed, many of them have mortgaged their labor heavily in advance by pre-purchasing at his store, inasmuch as the credit system is worked among them for all it is worth. They are adepts in driving a bargain, shrewd and patient. The traders know this now, to the grievous cost of many of them.

If everything is auspicious, wind and tide the next morning, after sailing, bring the vessel well upon the ground. The headlands are made out and noted; the natives slip into their bidarkas as they are successively dropped over the schooner's side while she jogs along under easy way, until the whole fleet of twenty or thirty craft is launched. The trader stands by the rail and shakes the hand of each grimy hunter as he steps down into his kyack, calling him, in pigeon-Russian, his "loob-aiznie droög," or dear friend, and bids him a hearty good-by. Then, as the last bidarka drops, the ship comes about and speeds back to the port which yesterday morning she cleared from, or she may keep on, before she does so, to some harbor at Sannak, where she will leave at a preconcerted rendezvous a supply of flour, sugar, tea, and tobacco for her party.

If the weather be not too foggy and the sea not very high, the bidarkas are deployed into a single long line, keeping well abreast, at intervals of a few hundred feet between. In this manner they paddle slowly and silently over the water, each man peering sharply and eagerly into the vista of tumbling water just ahead, ready to catch the faintest evidence of the presence of an otter, should that beast ever so slyly present even the tip of its blunt head above for breath and observation. Suddenly an otter is discovered, apparently asleep, and instantly the discoverer makes a quiet signal, which is flashed along the line. Not a word is spoken, not a paddle splashes, but the vigilant, sensitive creature has taken the alarm, and has turned

onto its chest, and with powerful strokes of its strong, webbed hind feet has smote the water like the blades of a propeller's screw, and down to depths below and away it speeds, while the hunter brings his swift bidarka to an abrupt standstill directly upon the bubbling wake of the otter's disappearance. He hoists his paddle high in the air and holds it there, while the others whirl themselves over the water into a large circle around him, varying in size from one-quarter to half a mile in diameter, according to the number of boats engaged in the chase.

The kalan has gone down—he must come up again soon somewhere within reach of the vision of that Aleutian circle on the waters over its head; 15 or 20 minutes of submergence, at the most, compel the animal to rise, and instantly as its nose appears above the surface the native nearest it detects the movement, raises a wild shout, and darts in turn towards it; the yell has sent the otter down again far too quickly for a fair respiration, and that is what the hunter meant to do, as he takes up his position over the spot of the animal's last diving, elevates his paddle, and the circle is made anew, with this fresh center of formation. In this method the otter is continually made to dive and dive again without scarcely an instant to fully breathe for a period, perhaps, of 2 or even 3 hours, until, from interrupted respiration, it finally becomes so filled with air or gases as to be unable to sink, and then falls at once an easy victim. During this contest the Aleuts have been throwing their spears whenever they were anywhere within range of the kalan, and the hunter who has stricken the quarry is the proud and wealthy possessor beyond all question or dispute.

In this manner the fleet moves on, sometimes very fortunate in finding the coveted prey; again, whole weeks pass away without a single surround. The landings at night are made without any choice or selection, but just as the close of the day urges them to find the nearest shore. The bidarkas are hauled out above surf-wash and carefully inspected. If it is raining or very cold, small A-tents are pitched, using the paddles and spears for poles and pegs, into which the natives crowd for sleep and warmth, since they carry no blankets or bedclothes whatever, and unless the wind is right they dare not make a fire, even to prepare the cherished cup of tea, which they enjoy more than anything else in the world, not excepting tobacco. After ninety or a hundred days of such employment, during which time they have been subjected to frequent peril of life in storm, and fog-lost, they repair to the rendezvous agreed upon between the trader and themselves, ready and happy to return for a resting-spell to their wives, children, and sweethearts in the village whence we saw them depart. They may have been so lucky as to have secured forty or fifty otters, each skin worth to them at least $50 to $60, and, if so, they will have a prolonged season of festivity at Unalaska, when they get back. Perhaps the weather has been so inclement that this party will not have taken a half-dozen pelts; then gloomy, indeed, will be the reception at home.

While the "spearing surround" of the Aleutian hunter is orthodoxy, the practice, now universal, of surf-shooting the otter is heterodoxy, and is so styled among these people, but it has only been in vogue for a short time, and it is primarily due to our traders, who, in their active struggle to incite the natives to a greater showing of skins, have loaned and have given, to the young hunters in especial, the best patterns of rifles. With these firearms the shores of many of the Aleutian channels, Sannak, and the Chernaburas are patrolled during heavy weather, and whenever a sea otter's head is seen in the surf, no matter if a thousand yards out, the expert, patient marksman shoots seldom in vain, and if he does miss the mark he has a speedy chance to try again, for the great distance and thunderous roar of the breakers prevent the kalan from hearing or taking alarm in any way until it is hit by the rifle bullet. Nine times out of ten when the otter is thus struck it is in the head, which is all that the creature usually exposes. Of course such a shot is instantly fatal, so that the hunter

has reason to sit himself down with a long landing-gaff and wait serenely for the surf to gradually heave the prized carcass within his ready reach.

Last, but most exciting and recklessly venturesome of all human endeavor in the chase of a wild animal, is the plan of "clubbing." You must pause with me for a brief interval on Sannak to understand, even imperfectly, the full hazard of this enterprise. We can not walk, for the wind blows too hard—note the heavy seas foaming, chasing, and swiftly rolling by, one after the other—hear the keen whistle of the gale as it literally tears the crests of the breakers into tatters, and skurries on in sheets of fleecy vapor, whirring and whizzing away into the darkness of that frightful storm which has been raging in this tremendous fashion, coming from the westward, during the last three or four days without a moment's cessation. Look at those two Aleuts under the shelter of that high bluff by the beach. Do you see them launch a bidarka, seat themselves within, and lash their kamlaykas firmly over the rims to the man-holes? And now observe them boldly strike out beyond the protection of that cliff and plunge into the very vortex of the fearful sea, and scudding, like an arrow from the bow, before the wind, they disappear almost like a flash and a dream in our eyes!

Yes, it looks to you like suicide; but there is this method to their madness: These men have, by some intuition, arrived at an understanding that the storm will not last but a few hours longer at the most, and they know that some 10 or 20 or even 30 miles away, directly to the leeward from where they pushed off, lies a series of islets, and rocks awash, out upon which the long-continued fury of this gale has driven a number of sea-otters that have been so sorely annoyed by the battle of the elements as to crawl there above the wash of the surf, and, burying their globose heads in heaps of sea-weed to avoid the pelting of the wind, are sleeping and resting in great physical peace until the weather shall change; then they will at once revive and plunge back into the ocean without the least delay. So our two hunters, perhaps the only two souls among the fifty or sixty now camped at Sannak who are brave enough, have resolved to scud down on the tail of this howling gale, run in between the breakers to the leeward of this rocky islet ahead of them, and sneak from that direction over the land and across to the windward coast, so as to silently and surely creep up and on to the kelp-bedded victims, when, in the fury of the storm, the fast-falling footsteps of the hunter are not heard by the active yet somnolent animal ere a deadly whack of his short club falls upon its unconscious head. The noise of such a tempest is far greater than that made by the stealthy movements of these venturesome natives, who, plying their heavy, wooden bludgeons, dispatch the animals one after another without alarming the whole number. In this way two Aleutian brothers are known to have slain 78 otters in less than one hour.

If these hardy men, when they pushed off from Sannak in that gale, had deviated a paddle's length from their true course for the islet which they finally struck, after scudding 20 or 30 miles before the fury of wind and water, they would have been swept on and out into a vast marine waste and to certain death from exhaustion. They knew it perfectly when they ventured, yet at no time could they have seen ahead clearly, or behind them, farther than a thousand yards. Still, if they waited for the storm to abate, then the otters would all be back in the water ere they could even reach the scene. By doing what we have just seen them do, they fairly challenge our admiration for their exhibit of nerve and adroit calculation, under the most trying of all natural obstruction, for the successful issue of their venture.

In conclusion, the writer calls attention to a strange habit of the Aleutian otter-hunters of Attu, who live on the extreme westernmost island of the grand Alaskan archipelago. Here the kalan is captured in small nets,* which are spread out over the floating kelp-beds or "otter-rafts," the natives withdrawing and watching from

---

*Sixteen to 18 feet long, 6 to 10 feet wide, with coarse meshes; made nowadays of twine, but formerly of seal and sea-lion sinews.

the bluffs. The otters come out to sleep or rest or sport on these places, get entangled in the meshes, and seem to make little or no effort to escape, being paralyzed, as it were, by fear. Thus they fall an easy prey into the hands of the captors, who say that they have caught as many as six at one time in one of these nets, and that they frequently get three. The natives also watch for surf-holes or caves awash below the bluffs; and, when one is found to which a sea otter is in the habit of going, they set this net by spreading it over the entrance, and usually capture the creature, sooner or later.

No injury whatever is done to these frail nets by the sea otters, strong animals as they are; only stray sea lions and hair seals destroy them. There is no driving an otter out upon land if it is surprised on the beach by man between itself and the water; it will make for the sea with the utmost fearlessness, with gleaming eyes, bared teeth, and bristling hair, not paying the slightest regard to the hunter. The Attu and Atka Aleuts have never been known to hunt sea otters without nets, while the people of Unalaska, and those eastward of them, have never been known to use such gear. Salt-water and kelp appear to act as disinfectants for the meshes, so that the smell of them does not repel or alarm the shy, suspicious animal.

The following tabulated statement gives the figures for the pelagic fur-seal fishery and sea-otter hunting in 1888. The walrus and sea lions taken incidentally are also included:

San Francisco fur-seal and sea-otter fleet in 1888.

Name of vessel.	Rig.	Tonnage.	Value of vessel.	Value of outfit.	No. of crew. (*)	No. of boats.	Number of animals killed.†				Gross stock.	Average share of crew.
							Fur seals.	Sea otters.	Sea lions.	Walruses.		
Alexander	Sch.	49.52	$6,500	$3,000	16	4	220	55	......	......	$6,820	$150
Angel Dolly	Sch.	18.82	2,500	2,500	10	3	17	......	1	19	1,050	60
Annie	Sch.	25.27	2,500	2,600	12	3	1,193	......	......	......	6,704	200
City of San Diego	Sch.	46.16	4,000	3,000	18	4	363	34	......	......	6,000	83
Helen Blum	Sch.	62.87	10,000	4,000	26	7	200	140	......	......	16,000	166
Laura	Sch.	19.20	1,400	1,500	10	3	9	......	......	25	1,500	75
Lily L	Sch.	63.42	5,000	5,000	21	6	1,700	......	......	......	9,350	125
Mary H. Thomas	Sch.	93.08	12,000	4,000	28	7	20	50	......	......	5,000	75
O. S. Fowler	Sch.	33.68	3,000	2,300	15	4	366	......	......	40	4,196	125
Otter	Sch.	73.75	10,000	3,000	18	4	70	80	......	......	8,500	90
San José	Sch.	51.88	5,000	3,000	13	4	150	15	......	......	2,300	75
Vanderbilt‡	Sch.	92.87	5,000	3,900	26	7	147	11	......	......	1,835	30
Total	12	630.52	66,900	37,800	213	56	4,455	§385	1	‖84	69,255	......

*The nationality of the fishermen was as follows: United States, 141; Sweden, 18; Norway, 10; Japan, 3; British Provinces, 12; other countries, 29.

†In addition to the regular catch, 11 bear skins and 39 fox skins were landed by the fleet.

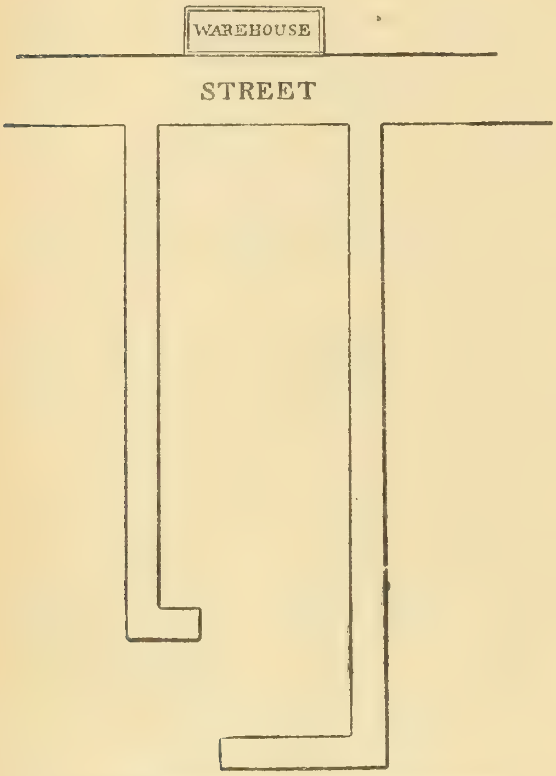
‡Lost in September.

§The figures given here apply only to the number of sea otters obtained by these vessels. The total number of sea-otter skins received at San Francisco (which is practically all that are taken on the coast) in 1888, as reported by the Alaska Commercial Company, was 2,510, large and small, and 161 cubs, the whole having a value of $218,625. The number and value of these which can properly be assigned to the fisheries of San Francisco are shown elsewhere.

‖In addition to these figures, the whale fleet took 36 walruses, the hides of which were valued at $600, and ivory valued at $998. The gross stock includes $647, the value of 1,176 pounds of walrus ivory, taken by 3 vessels.

THE MARKET FISHERY AND FRESH-FISH TRADE.

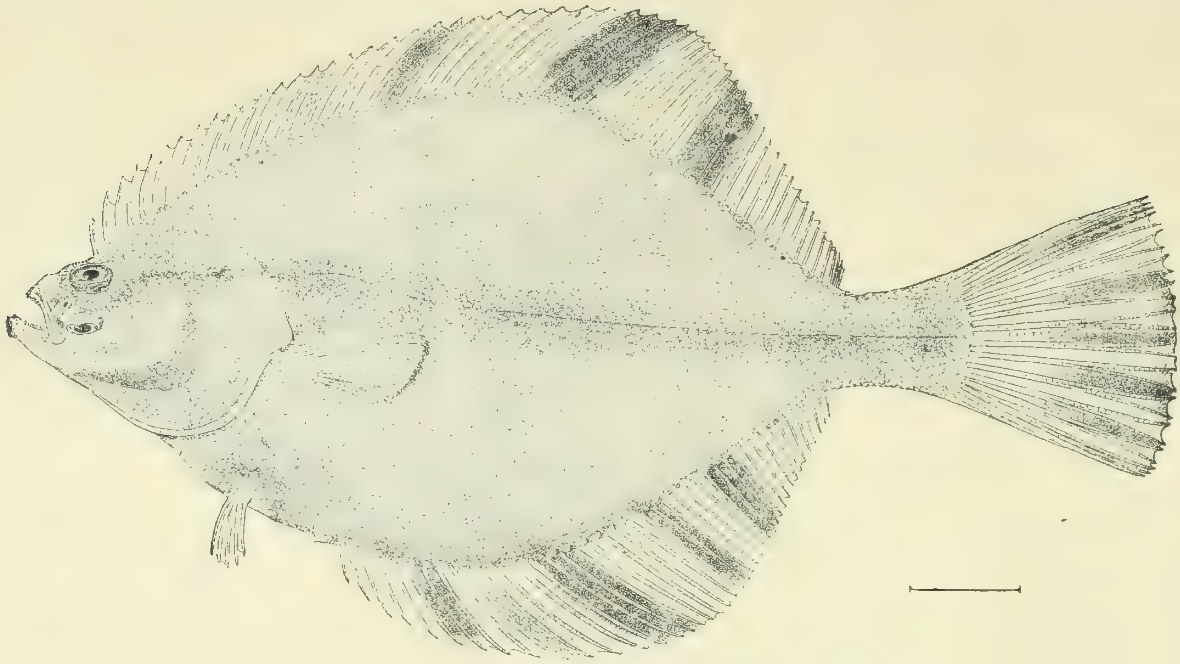
The market fishery of San Francisco, which practically includes nearly all of the fresh-fish fisheries of the region under consideration (except the salmon fishery for canning), is an important industry. Aside from the commercial value of the fishery, as a business enterprise, its importance to citizens of San Francisco in supplying them with a cheap and valuable food can scarcely be overestimated. The people depend so much upon this special industry for fresh food from day to day, that too much care can not be bestowed upon its proper conduct.



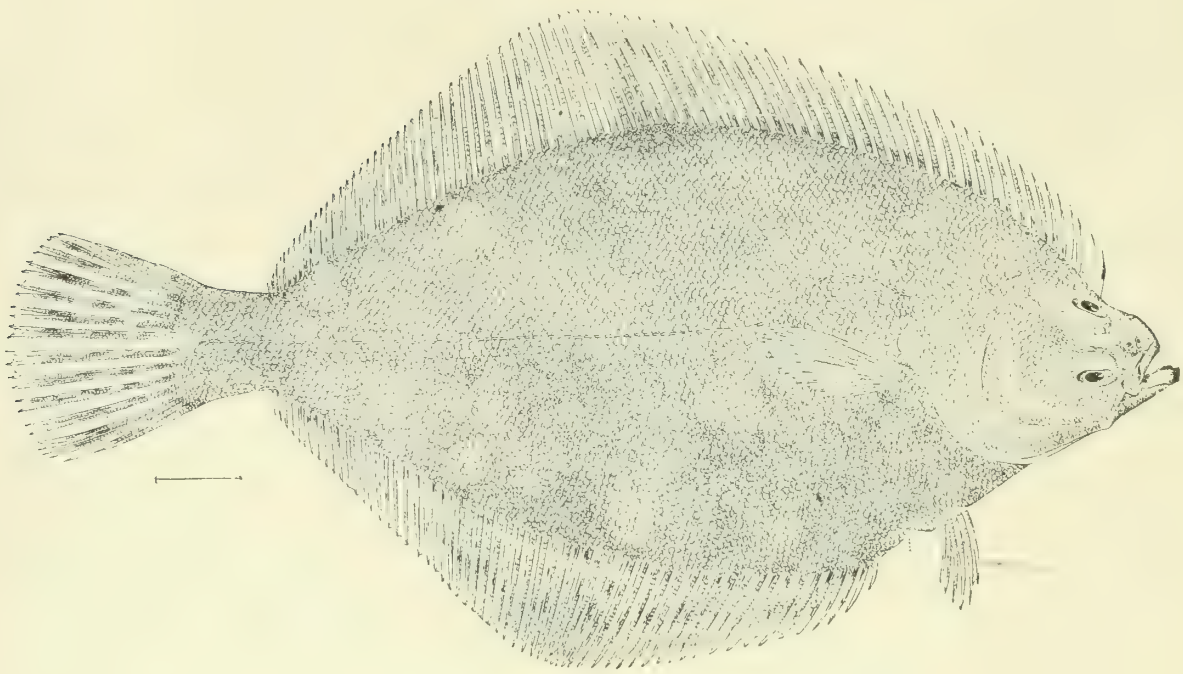
Plan of market dock, San Francisco.

While the market supply of fresh fish and other aquatic animals is largely the product of the San Francisco market fishery (including the Chinese fishing in the bay), important shipments are received from other localities; therefore, while this chapter deals only with the market fishery in a somewhat local sense, incidental allusion to other sources of supply can not well be avoided. This branch of the fishery is of such consequence that a special dock (with wharves, storehouse, etc.), for the accommodation of market boats, the landing of their fares, etc., has been built by the State, and is under the control of the harbor commissioners. It is located between Union and Greenwich streets, at the north end of the city front, and is known as "The Fisherman's Wharf." It was assigned to their use in 1884. It consists of two wharves, inclosing a dock or basin more than 400 feet long and 136 feet wide. One of the piers is 458 feet long by 24 feet wide, with an L at the end 119 feet long, extending across the outer part of the basin; the other is 366 feet long, and is so arranged that there is an entrance 70 feet wide between it and the L of the other wharf. In this inclosed dock boats lie safely at all times. On each pier are railings for drying nets, and just across the street, at the upper (or shore) end of the dock is a storehouse about 100 feet long by 35 feet wide, devoted exclusively to the storage and repair of fishing apparatus.

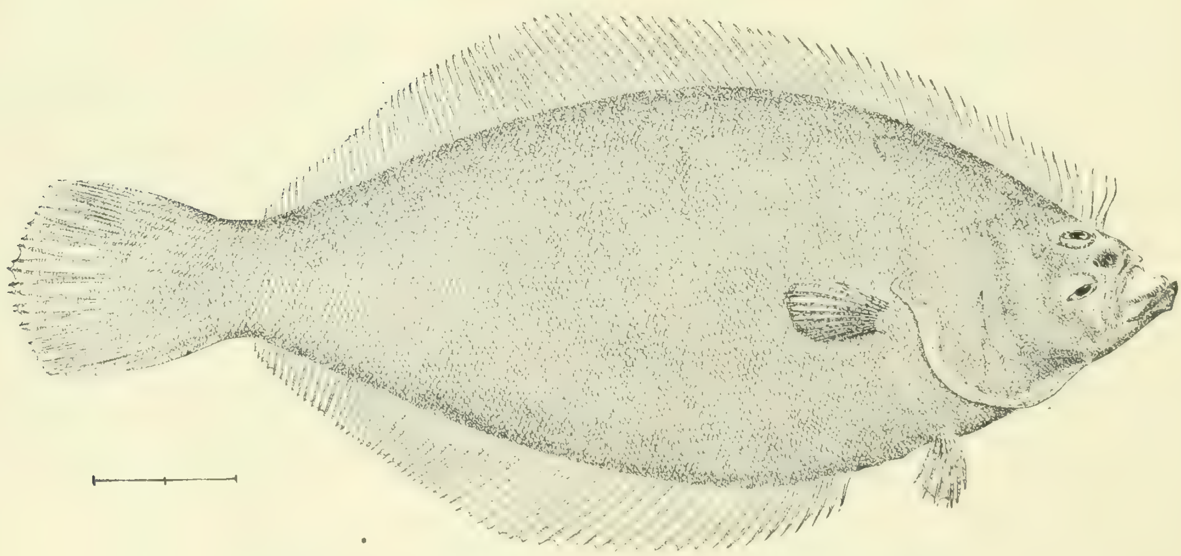
Species in the San Francisco markets, abundance, seasons, etc.—The San Francisco markets are supplied with a large variety of fresh fish and



THE CALIFORNIA FLOUNDER (*Platichthys stellatus*).



THE CALIFORNIA "SOLE" (*Lepidopsetta bilineata*).



THE SAN FRANCISCO SOLE (*Psettichthys melanostictus*).

other aquatic animals. Those mentioned below are most commonly taken by the market fishermen of this region.*

Flounders of several species are common in the market. The term "flounder" is specially applied to *Pleuronectes stellatus*. In discussing the flatfishes of the Pacific, Jordan says:

This species is known wherever found as the "flounder," all others being considered as bastard or false flounders. At San Francisco the name flounder is rarely used in a generic sense, but only as a special appellation of this species. It reaches a length of nearly 3 feet and a weight of 15 to 20 pounds, larger individuals being found northward than southward along the coast. The average length in the market is about 15 inches, and the weight 2 or 3 pounds. (The Fisheries and Fishery Industries of the United States, section I: The Food-Fishes of the United States, by G. Brown Goode, p. 184.)

Wilcox states that most of the numerous varieties of flatfishes found in the San Francisco market are now (1888) known by the common term of flounder, though he says that the trade names of "San Francisco sole," "Bay sole," or "English sole" are applied to one species—"the best of the flounders"—which is probably *P. stellatus*, but may be one or more of the other varieties. The diamond flounder (*Hypsopsetta guttulata*) is commonly known as the "turbot" at San Francisco. There are several species known to the fishermen and marketmen as "soles." Among these may be mentioned *Lepidopsetta bilineata*, *Parophrys vetulus*, *P. isolepis*, *Citharichthys sordidus*, *Psettichthys melanostictus*,† *Hippoglossoides jordani*,‡ *H. exilis*, and the "slippery sole" (*Cynicoglossus pacificus*). The two latter are taken chiefly in the paranzella. Sometimes great catches of *H. exilis* are made off Point Reyes in spring. Generally speaking, flounders and soles are abundant all the year, or sufficiently so to keep the market well supplied.

The common halibut (*Hippoglossus hippoglossus*) is rarely taken by the market fishermen, though the trawlers occasionally bring in a few, "and sometimes a vessel ventures to make a trip for fresh halibut to the northern banks." Lack of active demand prevents any systematic effort to supply the city with this species. The bastard halibut (*Paralichthys californicus*) is taken with other flatfish. The flounders sell at from 3 to 10 cents and the sole at from 6 to 10 cents per pound. The tomcod (*Microgadus proximus*), which Professor Jordan says is usually served under the name of "smelt" in San Francisco restaurants, is taken all the year, selling at from 6 to 10 cents per pound.

---

* The scientific names are given to most of the species to avoid misunderstandings that might arise from the local use of common names, many of which are so applied as to give no clue to their meaning, unless one is familiar with the idioms of the marketmen. The retail prices only are given, unless otherwise specified.

† Jordan says: "This species is everywhere a sole, and at San Francisco it is considered to have a better claim to that title than other species."

‡ "This species is known universally as the 'sole.' I have also heard the Italian name 'soglia' applied to it more often than to related species."—*Ib.*

The rock-cod or rockfish, of which there are many kinds, occur throughout the year, and sell at from 4 to 10 cents per pound. The following species are commonly called rock-cod: The "scorpene" (*Scorpæna guttata*), black-banded rockfish (*Sebastichthys nigrocinctus*), garrupa (*S. nebulosus*), flesh-colored garrupa (*S. carnatus*), red garrupa (*S. caurinus* and subsp. *vexillaris*), grass rockfish (*S. rastrelliger*), "vermilion fish" (*S. chlorostictus*), corsair (*S. rosaceus*)*, spotted corsair (*S. constellatus*), called also pink-spotted rock-cod. The red rockfish or rough red rock-cod (*S. ruber*) "is usually the 'red rockfish' *par excellence*," according to Professor Jordan. The rasher (*S. miniatus*) and the orange rockfish (*S. pinniger*) of Jordan are now commonly called "smooth red rock-cod" in San Francisco. The black rockfish (*S. mystinus*) is the most abundant species of this genus in the city markets, taking the year through, but owing to a prejudice against its color it does not sell at so high a price as the others. *S. melanops* is usually confounded with *S. mystinus*; it is far less common at San Francisco. The yellow-tail rockfish (*S. flavidus*) is another very abundant species and completes the list of those specially important.

The sea trout, or rock trout (*Hexagrammus decagrammus*), is abundant all the year, and sells at 6 to 10 cents per pound. The cultus-cod (*Ophiodon elongatus*), often called "codfish" here, is taken at all seasons; it sells for from 5 to 10 cents per pound. The ordinary weight ranges from 10 to 15 pounds, but individuals of 40 pounds are sometimes caught. Many small fish of this species are taken in nets in the bay, but the bulk of the catch is obtained on trawls set outside of the Golden Gate, along the coast and off the Farralones. The black "candlefish" or "black-cod" (*Anoplopoma fimbria*) is commonly known as the candlefish at San Francisco, where it is sometimes sold as Spanish mackerel. It is not so large nor so plentiful as farther north, particularly in the Strait of Fuca, and is little esteemed generally.

The term "perch" is applied to many species of the surf-fish family (*Embiotocidæ*) found at San Francisco, but Professor Jordan thinks this an unfortunate misnomer. Among these Wilcox mentions only the black surf-fish of Jordan (*Ditrema jacksoni*), which he designates as salt-water perch or "porgee." This is the most abundant species and the most common of the "perches" in the markets. It is taken all the year and sells at from 3 to 8 cents per pound. Jordan mentions fourteen other species belonging to this family of surf-fishes that occur at San Francisco, but some of them are of little commercial value and in some instances are used only for bait. The river perch (*Hysterocarpus traski* Gibbons) is taken in fresh water, chiefly in the Sacramento and San Joaquin Rivers. Considerable quantities are sold in San Francisco, which are mostly consumed by the Chinese.

---

* An excellent food-fish and very abundant on outside grounds resorted to by trawlers.

Mackerel (*Scomber colias*), according to Wilcox, occur from October to the middle of December, but are scarce. Their northern limit of migration is Monterey Bay; the price varies from 10 to 20 cents per pound, and they weigh 2 or 3 pounds each. In October, 1889, when the species was rare in the market, Dr. Bean found it selling at 30 to 50 cents per pound.

The Spanish mackerel (*Scomberomorus concolor*) is rare, and only a few are seen in the markets during August and September. It is highly prized, and sells readily at from $2 to $3.*

The bonito (*Sarda chilensis*) is abundant in its season, June to September, but not in much demand, selling at 15 to 50 cents each. It averages 12 pounds in weight.

The "horse mackerel" or scad (*Trachurus picturatus*) averages 3 pounds in weight, according to Wilcox, and is in market most of the year. The price ranges from 8 to 20 cents per pound. Professor Jordan places its northern limit of migration at Monterey, which locality it reaches in August. He says its weight is less than a pound, and in 1879 found it to be held in low esteem as a food-fish, though he did not know whether this was due entirely to its small size. The estimation of its value seems to have changed materially in the past decade.

The California pompano (*Stromateus simillimus*) is closely related to the butterfish of the Atlantic. It was very rare prior to 1870, but about 1879 was often found in such quantities that the catch could not all be sold. It is again very scarce, but a few are taken from June to August and are in demand at a price varying from 50 cents to $1.50 per pound. The fish is known both as pompano and butterfish in the San Francisco market.

The sea bass (*Cynoscion nobile*), sometimes called "white sea-bass," or when young, "sea trout," is one of the most valued and important species on the coast; it is caught from July to November; it averages about 15 pounds in weight; its price ranges from 1 to 10 cents per pound.

The little bass of San Francisco (*Genyonemus lineatus*) "often comes into the markets in large numbers," according to Jordan, who says that many are dried by the Chinese.

The kingfish (*Seriphus politus*), also called the queenfish, occurs all the year, but is specially abundant in summer, at which time it schools in great numbers in the surf along sandy beaches. Its price varies from 4 to 7 cents.

The Sacramento perch (*Archoplites interruptus*) "is known only by the name of 'perch.'" It is taken in great numbers from October to March in the lower reaches of the Sacramento and San Joaquin Rivers,

---

* The term "Spanish mackerel," as used in San Francisco markets, is commonly applied to the bonito, also called "skipjack," and "tuna" or horse mackerel. The true Spanish mackerel (*S. concolor*) is not caught north of Monterey Bay, where a few are occasionally taken in late summer or fall.

and is shipped to San Francisco, where it sells at from 4 to 8 cents per pound.

The "jewfish," or "black sea-bass" (*Stereolepis gigas*), is said to be an excellent food-fish, and the smallest are in demand in the market. It is generally plentiful in deep water about the Farralone Islands, but comparatively few are brought to market because of its great size. It is the largest food-fish on the coast; its maximum weight is about 500 pounds.

The striped bass (*Roccus lineatus*), which was artificially introduced into western waters about 1885, is now quite abundant, and may be included among the finest of the California market fishes.*

The barracuda, one of the most common food species, is in season from June to September; the price ranges from 4 to 12 cents per pound.

Salmon of several species and of varying excellence are found in the San Francisco markets. They constitute important objects of fishery and are taken in the bays and rivers of the region under discussion. Except, perhaps, in September, the markets are generally supplied with some kind of salmon, for shipments are received from various points along the northern coast. These include the quinnat or king salmon (*Oncorhynchus chouicha*), the silver salmon (*O. kisutch*), dog salmon (*O. keta*), humpback salmon (*O. gorbuscha*), and steelhead (*Salmo gairdneri*). The price ranges from 15 to 12 cents per pound. The black-spotted trout or "lake trout" (*S. purpuratus* var. *henshawi*) is in season from October to March, and in good demand, selling for from 18 to 25 cents per pound.

Smelt (*Atherinopsis californiensis*, *Osmerus thaleichthys*, *O. attenuatus*, and *Hypomesus pretiosus*) are most abundant from January 15 to September, though a few are seen in the markets in the intervening months. The largest catch is made in February, March, and April. Alexander remarks that "smelt-fishing is followed about 7 months in the year. It usually begins in February and is assiduously prosecuted till the middle of September, and not infrequently October is well advanced before the season is over." *A. californicus* is alone called smelt in this region. It grows to a large size, attaining a weight ranging from one-third of a pound to a pound.† After the principal run is over, silversides or sand-smelt of smaller size are taken with other species. The price is from 6 to 10 cents per pound.

The herring (*Clupea mirabilis*) is exceedingly abundant in its season, from October or November to about March 15,‡ and, judged by the

---

* Alexander states that in March and April, 1890, it had "recently been taken in such quantities that the price was reduced to 18 cents per pound." The ruling price prior to that time was $1 per pound.

† Jordan says of *O. thaleichthys* that "This species is known as smelt, especially in those parts of the coast where the *Atherinopsis* or California smelt is unknown."

‡ If the weather is dry and warm, herring do not remain so late in the spring, but if the season is wet and cold they are caught until the middle of March.

quantity disposed of, it is one of the most important species. It is sometimes taken in such quantities in San Francisco Bay in spring that 80 pounds can often be bought for 20 cents.* The market price, however, generally varies from 3 to 6 cents per pound.

The California sardine (*C. sagax*) is said to be almost exactly identical with the sardine of Europe. This is an important fact, as will appear in the discussion, in a subsequent chapter, of the preparation of sardines on this coast. It is taken here from May to November, and its market price is from 3 to 6 cents per pound.

The shad (*C. sapidissima*) is not indigenous to the waters of the Pacific coast, but has been artificially introduced there by the U. S. Fish Commission. The species shows a yearly increase, but is not yet abundant; it is taken chiefly in salmon nets, from April to December, and a few are seen in the markets throughout the year. The catch varies considerably from year to year. It often reaches a weight of 8 pounds, and averages between 4 and 5 pounds. The average price has been about 10 cents per pound.

The anchovy (*Stolephorus ringens*) is about half as large as the herring, and is an excellent food-fish as well as an important bait species. It is sold fresh in the market at from 3 to 5 cents per pound; when abundant and cheap it is salted for bait, to be used when fresh bait can not be obtained. Attempts to pickle it in spices for the trade were made as early as 1879, but it is only in recent years that any considerable quantities have been packed this way in half barrels, kegs, and tin cans. During 1888 the experiment of packing them in oil, as "sardines," was tried. Only a small amount was treated in this way, but it is said to have met with favor, and it is believed the experiment may lead to important results.

The sucker (*Catostomus occidentalis*) is a fresh-water species taken in considerable quantities at all seasons, but is little esteemed, the retail price being only about 2 cents per pound.

The "chub" of the San Francisco markets (*Phoxinus crassicauda*) is abundant in the Sacramento River at all seasons. It is one of the cheapest species, selling for from 1 to 3 cents per pound, and is eaten chiefly by the Chinese.

The Sacramento "pike" (*Ptychochilus oregonensis*) and another species (*P. harfordi*) are taken in the rivers of this region, particularly in the Sacramento. Many are brought to market, but they are coarse fish and in little demand outside of the Chinese quarter.

The "split-tail" (*Pogonichthys macrolepidotus*) and two other fresh-water species (*Lavinia exilicauda* and *Orthodon microlepidotus*) abound

* Wilcox states that "herring, sardines, and anchovies are taken in abundance in San Francisco Bay. The herring are about 8 inches long, five weighing a pound; prices vary with the catch. Sardines are somewhat larger than herring and run in schools by themselves."

in the streams of this region and, like those last mentioned, are sold chiefly to the Chinese.

The German carp (*Cyprinus carpio*), originally introduced by the U. S. Fish Commission, is now abundant at all seasons; it sells at from 3 to 8 cents per pound. From 75,000 to 100,000 pounds are annually disposed of in the San Francisco market.

The fresh-water catfish (*Amiurus nebulosus*) is another market species brought from the East. Its price varies from 5 to 10 cents per pound.

Eels are scarce all the year and are in much demand, the price ranging from 50 to 75 cents each.

The white sturgeon (*Acipenser transmontanus*) is abundant and meets with a good demand at all seasons, selling at from 4 to 12½ cents per pound. Jordan considers it "one of the most important species in the San Francisco market." It is sold in the markets under the trade names of "sturgeon," "bass," "white salmon," and "tenderloin sole." The latter is the choice piece. The trade names generally apply to the particular part of the fish the "cut" is taken from, and the manner in which it is carved. A lengthwise cut has a different trade name and a different price from a piece that is cut crosswise. The ordinary weight of this species is from 50 to 100 pounds; it often attains a weight of 300 to 500 pounds, and one taken in 1876 is said to have reached 800 pounds.

The green sturgeon (*A. medirostris*) is not in favor as a food-fish. Ten years ago, according to Jordan, it was not used for food, and had the reputation of being poisonous. Now it is found in the markets only when the white sturgeon is scarce. Both varieties are reported less plentiful than formerly.

Skates (*Raia inornata* and *R. binoculata*) are abundant and in good demand in the markets. The small ones sell at from 10 to 25 cents each, and the large fish at from 2 to 6 cents per pound.

Shark's fins are sold in the market, but no special attempt is made to get them. The very few brought in are taken incidentally. The price is 10 to 25 cents each.

Dogfish (*Squalus acanthias*) are numerous; they are sold to the Chinese.

Squid (*Ommastrephes tryoni* Gabb) and octopus (*Octopus punctatus* Gabb) are largely eaten by the Chinese, and are chiefly a product of the Chinese fishery. Squid come mostly from Monterey, and are mentioned here principally for the purpose of calling attention to the market supplies; the price is from 5 to 10 cents per pound. Octopus retail at from $1.50 to $2 each; if cut up, each of the arms sells for 25 cents.

Oysters have been discussed in a special chapter.

Clams (*Mya arenaria* and *Tapes* [*Cuneus*] *staminea* Conrad) are found in the markets at all seasons. The soft clam, or *Mya*, is very abundant in San Francisco Bay, but the round clam is obtained from the northern coasts, and in limited numbers. It is believed by competent authority that *M. arenaria* has been introduced, incidentally, with oysters brought

from the Atlantic coast. Dr. R. E. C. Stearns, adjunct curator of mollusks in the U. S. National Museum, has ably discussed this question in a paper entitled "*Mya arenaria* in San Francisco Bay," which appeared in the American Naturalist, May, 1881. He says:

Since 1874, the date of the description [by Dr. W. Newcomb, who named it *M. hemphillii*], the *Mya* has become abundant, and is found for miles alongside the easterly shore of the bay, and is now the leading clam in the markets of San Francisco and Oakland, superseding to a great extent the previous "clams," *Macoma nasuta* and *Tapes* (or more properly, *Cuneus*) *staminea* Conrad, in its varieties, especially *diversa* Sby., and the now dominant clam of the fish stalls is found exhibiting all of the characteristics of *Mya arenaria*, and is universally conceded to be the same as the Atlantic species.

Mussels (*Modiola capax*) are plentiful. They sell for 4 cents per pound. The large common crab of the Pacific coast (*Cancer magister*) occurs in greatest numbers outside of the Golden Gate. It is an important source of food supply. It can be taken at all seasons and sells at from 5 to 10 cents. It sometimes attains a weight of 4 pounds. Shrimp are extensively sold in the market; they are discussed at length in the chapter on the shrimp fishery. Prawns (*Pandalus danæ*) are obtained in moderate supply; the price varies from 15 to 20 cents per pound.

Frogs are taken in the vicinity of San Francisco; they also come from San Mateo, Marin, and Kern Counties. The average market price is $3 per dozen, but it is sometimes as high as $5.

Terrapins are obtained from the swamps, ponds, and lakes of this region, but chiefly from the San Joaquin Valley. They average about 2 pounds each and sell at $3 per dozen.

Sea turtles are kept in the market but are not taken here. They come from the Mexican coast; their average weight is 80 pounds; the market price is $3.50 each.

Destruction of fish by sea lions.—Much has been said and written about the destruction of fish in San Francisco Bay and vicinity by sea lions and seals, of which there are large numbers about the entrance of the Golden Gate and at the Farallones. They are commonly seen in the bay and even enter the rivers. Opinion is divided, however, as to whether the scarcity of fish is due to the seals or to the capture of quantities of immature fish by the Chinese. This is an interesting subject, and considerable information has been gathered bearing on both sides of the question; but in the present undetermined status of the case it is only necessary to call attention to the scarcity of market fish on some of the grounds and the alleged causes therefor.

Fishing grounds, seasons, etc.—Herring, smelt, salmon, shad, flounders, perch, and sturgeon are the most important varieties and constitute the bulk of the catch of the market fishermen in San Francisco, San Pablo, and Suisun Bays. These species are taken chiefly with sweep nets or paranzellas, stationary and drift gill nets, which are operated wherever fish may be temporarily most abundant. The first run of herring, about the last of October or early in November, generally strikes into

Richardson's Bay as the fish are passing through the Golden Gate, but they often go across to the east side of San Francisco Bay at the same time. About October 20 gill nets are set in Richardson's Bay and upon the shallows on the east side of San Francisco Bay, from Union City Creek to Alameda Pier, and off Point Richmond. Fishing continues in these localities until about the middle of March, but the fish change their positions frequently, being influenced by wind and weather, and occasionally schools of herring enter the adjoining bays. The greater part of the catch is taken in Richardson's Bay, where from 35 to 40 boats engage in the fishery, which succeeds the smelt fishing.

The principal fishing grounds for smelt are in the southern part of San Francisco Bay. Smelt are taken with gill nets and seines in the shoal water of the east side of the bay, between Alameda Pier and Union City Creek, from November to February. A favorite fishing ground from January 15 to June 15 is in the channel from off Point San Bruno to Potero Point, at the head of the bay, and some are caught here even as late as August. Smelt are taken in April from Point San Bruno to Point San Mateo, and in May in the shallow water north of Oakland Pier as far as Brooks Island. Another locality resorted to in July and August is near the shore, a short distance south of the city, between Mission Rock and Point Avisadero.

During April and May fishing for salmon with drift gill nets begins on the ground from off Point Richmond to Oakland Pier; this is continued to July; the catch is small here during June and July. In May and June nets are set for salmon in the channel south of Oakland Pier, and a few fish are taken there. From April to September salmon are netted in San Pablo Bay, from Point San Pedro to Benicia, from Mare Island up Napa Creek, and on the north side of the bay, in the channel leading to Petaluma Creek, and on the shoals off Sonoma Creek. Salmon are taken throughout Suisun Bay in spring and fall.

Shad are caught incidentally in nets set for other species in San Francisco Bay and the adjacent bays, also in the Sacramento River.

Flounders are taken all over San Francisco and San Pablo Bays, chiefly where the water is shallow, so that the "sweep nets" or paranzellas can be most successfully operated. Specially favorable localities in San Pablo Bay, both for flounders and sturgeon, are the broad, flat reach (inside the 6-foot curve) on the north side of the bay (see map, plate VI), the bend west of Penole Point, and the deep, bay-like curve between the latter and Point San Pablo.

Sturgeon occur all over the bays and streams emptying into them, but are generally most numerous in the shallow reaches near shore.

Fifteen of the largest market boats engage in trawl-line fishing outside the Golden Gate at all seasons of the year whenever the weather will permit. A large number follow this fishery in summer. Between April and November trawls are set along the coast south of the Golden Gate as far as Pigeon Point, but the "south shore" is not frequented in

winter. The "north shore," between Duxbury Point and Bodega Head, a distance of about 40 miles, is a favorite fishing ground at all seasons. The catch on trawl lines is made from ½ to 5 miles from the shores above mentioned, and also off Noonday Rock, and the North, Middle, and South Farallones. The catch consists chiefly of the numerous varieties of rock-cod and cultus-cod, with an occasional halibut and greater or less quantities of other species taken on hooks.

Fishermen, lay, etc.—The market fishermen of San Francisco, exclusive of the Chinese, are, with very few exceptions, from the south of Europe. Italians predominate, but Slavonians, Greeks, Portuguese, and Spaniards are numerous. They have brought from their native lands the peculiarities which distinguish fishermen of those countries; and one standing on the market wharf at San Francisco watching the arrival of the fishing feluccas, and noting the dress, manner, and language of the fishermen (for many speak their mother tongues), might easily imagine himself the witness of a fish-marketing scene on the Mediterranean coast. The men are hardy, are reputed to be brave and skillful, are industrious, and are willing to work for small returns if necessary. It has been said of them that—

> The fisherman's life is full of hardship and work. The dangers of the calling are manifold. They are hardy, temperate, and frugal. Their days are spent on the water and their families see but little of them. They are generous and kind to each other. They are keen in business matters, and do not allow themselves to be cheated by dealers on shore. Some of them have amassed a competency and retired from business. There are but few instances of poverty to be seen among them, and nearly all of them have a snug sum put by for emergencies. * * * They are seldom idle. After a trip has been made and the boat's load of fish sold, they may generally be found on their boats or the adjoining wharf, repairing or drying their nets and seines, making lines and adding hooks, or doing some kind of labor on their boats, preparatory to another fishing voyage. (San Francisco Chronicle, November 11, 1883.)

This rose-tinted picture of success and "competency" is undoubtedly overdrawn. It is true that some have been moderately successful, and, by close economy, have become boat-owners or dealers on shore. But the majority have not been so "lucky," and, though there may be little actual destitution, the earnings are no larger than those of the New England fishermen who follow their trade throughout the year. There has, however, been a marked improvement in this respect in the past ten years. A decade ago Jordan found "the wages earned by the bay fishermen in San Francisco pitifully small, very few of them earning more than the $3 per week, necessary to pay their board bill." Earnings vary greatly in different seasons, but in 1889 it was stated that the "high line" of the fleet shared $700, while the smallest share was estimated to have been $300. The average wages was placed at $400 by competent authority. Naturally they are clannish and opposed to having others secure anything like a controlling influence in the trade. If occasion calls for it, they have the reputation of standing by each other to the bitter end, and this spirit of trade union has, no doubt, been a

most important factor in maintaining their unquestioned supremacy in the market fishery.

They have several societies, among which the California Fishermen's Union, on Vallejo street, is perhaps the most important.* Here they meet to discuss and act upon all matters relating to their calling and which may affect their welfare, special attention being given to State laws regulating the fisheries.

The lay upon which the fishermen work is as follows: The owners of a boat furnish all fishing gear—lines, nets, etc.—and receive one share. In settling, the cost of all provisions and outfit, other than fishing gear, is deducted from the gross stock, and the remainder is divided equally, the boat counting as one man in the division and getting one share, while an equal amount goes to the captain and each member of the crew. Some fishermen own their boats, but in many cases the little vessels belong to the marketmen.

The fishermen find constant employment in pursuit of the many kinds of fish that frequent these waters. Certain species are always arriving to take the places of those departing. This necessitates changes in gear and continuous activity.

The financial success of the San Francisco fishermen is often seriously affected by the great quantities of fish received from stations on the coast, making the price unremunerative. Then the local market fisherman gets but little for his labor, and he complains most bitterly.

Boats.—The majority of the market boats of San Francisco and vicinity are feluccas, but some are cat-rigged. Wilcox gives the number regularly marketing their catch at the city (exclusive of Chinese craft) as 126, which he classifies as follows: 8 boats from 32 to 36 feet in length, 51 from 20 to 25 feet, 20 from 18 to 20 feet, and 47 from 15 to 18 feet long.

An act of the California legislature, approved March 21, 1887, requires all fishing boats to obtain a license. In many cases, however, especially in thinly settled coast sections, the law has not been thoroughly enforced, and the records of boats licensed generally gives an inadequate idea of the actual number employed. In the region including San Francisco Bay and the Sacramento and San Joaquin Rivers, 452 boats, all told, were reported as licensed. These are divided into five classes, the classification being based on the number of men working on a boat. Class A includes boats with less than three men, and each boat of this class pays $5 license fee. Those with three men come under class B, and pay $7.50. Then follow the classes C, D, and E, $2.50 extra being charged for each man carried in a boat in addition to

* A writer in the San Francisco Chronicle, of November 11, 1883, says: "The fishermen are nearly all members of the Fishermen's Protective and Benevolent Association, which has had an organization here since 1877, with a large membership. * * * The office of the association is located at 23 Vallejo street."

FISHING FELUCCA.

three. Thus, a crew of four pays $10, five men are taxed $12.50, and so on.*

The market fisherman paints and repairs his own boat, makes new sails, repairs old ones, and attends to the fitting of rigging. The boats are built at San Francisco by Italians and Greeks, who also turn out small craft of this type for use elsewhere along the coast. There are three boat-building shops (with an average value, with accessories, etc., of about $1,000) that employ two or three men each.

Apparatus and methods of fishing.—The frequent changes in fishing caused by the appearance or departure of certain species compel the market fishermen to use a great variety of apparatus to secure the best results. It is common for a boat to be fully equipped with hand and trawl lines, salmon gill nets, herring or smelt nets, seines, etc.; but most of this gear is generally stored on shore, the boat carrying only that required for the special fishery it is employed in at the time. Many small boats engage in crab fishing throughout the year and require no change of gear.†

The crews of the boats vary from 2 to 6 men, the number depending upon the size of the craft and the fishery it is following.

The larger class of boats generally pursue the flounder, rock-cod, smelt, herring, salmon, etc., in their respective seasons, and employ all varieties of gear known to the trade. The hand line is perhaps the most common form of apparatus. Whatever other gear may be put into storage, eight hand lines are generally kept on each boat, as they occupy little space and can often be utilized to good effect, when otherwise the time might be lost, as when a boat is becalmed. Occasionally the trawl lines do not find good fishing, owing to the poor quality of the bait, which may have been on the hooks longer than usual, or to various other causes known to fishermen; and at such times the hand lines play an important part in securing a fare. Sometimes two-thirds of the day's catch will be taken on hand lines. There are three sizes of lines. The smallest is about 20 fathoms long, with a sinker weighing one-half pound. A medium size is twice as long and with double the weight of sinker; the longest used is 75 fathoms, with a lead weighing 2 pounds. They cost, respectively, 35 cents, 60 cents, and $1.

From 30 to 40 baskets of trawl lines are carried by each boat when trawling. Each basket holds a little over 100 fathoms of ground line, with from 150 to 180 hooks attached. The gangings are 3 feet long and 3½ feet apart. The cost per 1,000 hooks, including buoy lines, etc., required for setting them, is $27. The trawl baskets are oval in form,

* This tax is considerable in the aggregate, reaching the sum of $3,010 for licenses issued for Humboldt, Tehama, and Shasta Counties, and the region previously mentioned, viz: Class A, $2,485; class B, $52.50; class C, $170; class D, $287.50; class E, $15.

† Alexander remarks that "on an average 100 boats follow crab fishing the year round; the smallest boats, as a rule, are used in this fishery."

made of wicker work, and are similar to those used by the Irish market fishermen sailing from Boston. They cost 50 cents each.

The method of fishing with trawls is similar to that on the Atlantic coast, when sailboats are employed. The lines are first baited and coiled in the baskets ready for setting. When the fishing ground is reached the buoys, anchors, and buoy lines,* are bent to the ground lines, and when all is ready the boat stands along under easy sail (or is rowed if there is no wind) while the first buoy is thrown over, followed by the buoy line, after which the trawl is paid out. If the ends of the sections in the baskets have not previously been tied together they are quickly bent at the proper time; and this goes on until all the hooks are out, when the last end of the ground line is followed by the anchor, buoy line, and buoy. Five to 35 baskets of trawl are set at one time, the quantity varying with conditions of weather, etc. The gear is hauled in the ordinary manner and the fish are generally stowed in tiers in the hold, where they are arranged heads up, and lie that way until the boat reaches the market dock.

The herring gill nets used in San Francisco Bay are 30 fathoms long. Seven to ten of these are set in a string. Each boat usually has ten nets, but all of them may not be set at the same time. Smelt nets are often set for herring, according to Alexander. These are 40 fathoms long, 10 to 12 feet deep, with mesh varying from 2 to $2\frac{1}{4}$ inches. They cost $25 each. As a rule, 5 smelt nets are set in a string.

Salmon gill nets vary in size with the locality, those used in the bays and the Lower Sacramento being larger than the up-river gear. The former range in length from 40 to 50 fathoms, are 40 to 45 meshes deep; mesh, $8\frac{1}{2}$ to $8\frac{3}{4}$ inches. Several are fastened together for drifting, making essentially one net of 250 to 500 fathoms in length, worth from $200 to $400. Each boat usually has ten nets, with an average value of $30 each. The method of operating these is the same as on the Sacramento River.

The sea-bass gill nets are 20 fathoms long, $8\frac{1}{4}$-inch mesh, and 40 meshes deep. They are made by the fishermen. The bulk of the twine of which they are knit comes from Boston, Mass.; some is imported from Europe; the former costs 60 cents per pound and the latter 85 cents.

The barracuda gill nets are essentially the same as used elsewhere, and are operated in a similar manner.

The trammel nets, locally called "drift nets," or "3-mesh nets," are usually 50 fathoms long and 10 to 11 feet deep. The large mesh varies from 17 to 18 inches and the small mesh from $5\frac{1}{2}$ to 6 inches. They cost $30 each. The web for the central net is machine-made, but the rest of the net is made by the fishermen.

The paranzella is the form of net ordinarily used for catching flounders and such other species as can be taken in this apparatus. By

* Stones are very often used for anchors, and tin cans are in favor for buoys.

Americans, who are unfamiliar with its European origin and name, it is called "flounder net," "drag net," "drag seine," "bag seine," "deep-water drag seine," etc., the name in each case having an allusion to some peculiarity of form, operation, or species taken in it. The size commonly used for flounder fishing in San Francisco Bay and contiguous waters has a conical bag in the middle (at the bunt), 18 feet deep and 5 feet wide across its mouth. The wings are each about 150 feet long, 15 feet deep where they adjoin the bag, and taper to 12 feet in depth at the extreme ends. The mesh at the wing ends is from 2½ to 3 inches, but grows smaller towards the bunt, where it is only 1 inch, while the bag has a ½-inch mesh; the cost is $125. These nets are often, if not generally, operated like a drag seine, being hauled over the bottom by men standing on the shore or in shallow water near the shore.

Alexander states that "drag nets that are hauled on shore are from 360 to 420 feet long, 18 to 24 feet deep, bag 18 feet long, mesh of wings 4½ inches, of bag 2½ inches." Those used in deep water have a bag 30 or 40 feet deep. This extra length prevents the escape of fish. When the paranzella is operated by boats the method is essentially the same as at Santa Cruz. Fishing with this is perhaps most common in the bays where the water is shallow.

The steam tug *U. S. Grant* operates a paranzella on sandy patches in deep water off Point Reyes and the Farallones. Her catch is chiefly flatfish, but other species are also sometimes taken. She carries a crew of seven men all told, namely, captain, engineer, one fireman, four fishermen or deck hands.* The following account of a trip on the *Grant* is extracted from the San Francisco Call of April 4, 1887:

Near the stern of the boat * * * two booms, 45 feet in length, project over the sides and water, which contain ropes attached to the mouth of the net. The nets are 100 feet long by 40 feet wide, and there are always two of them aboard. The fishing is done by trolling. When the vessel arrives at the fishing ground she moves along very slowly with the net trailing at the bottom of the ocean. The nets to the fish appear stationary, and the piscatorial idiots swim through the mouth and are thus easily caught. No bait is used. Heavy sinkers are employed to hold the net down to the bottom. Off Point Reyes, the usual fishing ground of the vessel, the bottom is at 40 fathoms. The Call reporter, who was courteously permitted to enjoy a trip on the steamer, arose at 3 o'clock last Friday morning, and at 4 o'clock found himself at Green street wharf, off which the *U. S. Grant* lay. * * *

It was yet far from dawn when the little vessel cast off her moorings at the wharf and picked her way carefully through the shipping out into the stream. The morning was a mild and pleasant one, and the stars overhead afforded sufficient light to steer by. Once out into the stream the little steamer puffed away and made rapid progress toward the Heads. The jutting hills on either shore and in the water looked black and ominous, but the electric and other lights blazing everywhere relieved the prospect considerably. A fresh and invigorating breeze was blowing in from the ocean, but it was too cold for comfort. Soon the vessel began to roll; * * * she had passed through the Golden Gate, and before the sun had risen very high she was off Point Bolinas. By half past 7 she had arrived off Point Reyes, the fishing ground,

* The captain receives $100 per month, the engineer $100, the fireman $50, and the fishermen $40 each.

a distance of about 35 miles from this city. The morning was cool, but clear and sunny. The engine was stopped, and the net was got ready for business. The meshes were soon in the water, and being lowered by the ropes to the bottom. The net was suffered to remain at the bottom until about 11 o'clock a. m., and during that time the craft gently moved along, bobbing up and down on the swell. * * * A moment or two before the performance of hauling in the net was begun not a bird was visible anywhere, but as soon as the fishermen commenced to haul in the almost interminable length of rope, to the accompaniment of their "yo-heave-hos," the very air became alive with sea fowl.

Professor Jordan gives the following account of the history of paranzella fishing at San Francisco, and its effect upon the abundance of fish in the bay:

Previous to 1876 fishermen working with seines for the San Francisco market made very good wages, occasionally running as high as $25 per night for each seine. In 1876 some of the fishermen secretly ordered a drag net to be made, and took it out for trial without the other fishermen knowing it. The experiment was entirely successful, and the drag nets have been used in San Francisco since. Their introduction naturally created quite a stir among the other fishermen, especially among those who had previously supplied the market with tomcod and flounders. Threats were made to burn both drag nets and the large boats which were used to pull them, and for several months it was necessary to keep watch over the "paranzellas." There is still a great deal of opposition to the use of these nets, fishermen complaining that by means of them so many young fishes, especially flounders, are destroyed that the fishing around San Francisco is thereby greatly injured. Fishermen tell me that they are in very general use along the shores of the Mediterranean. San Francisco is probably the only place where they have been introduced into this country.

* * * * * * *

As soon as the "paranzellas" were introduced a large reduction took place in the price of such fish as they caught. Before their introduction tomcod sold, wholesale, for from 25 cents to 40 cents per pound, and they never reached a lower price than 8 cents per pound in the summer. *Parophrys vetulus* sometimes in the winter brought as high as 80 cents per pound, and in summer sold for from 10 cents to 15 cents per pound. Wholesale prices now never range higher in winter than 20 or 25 cents for *Parophrys*, and 8 or 10 cents for tomcod, and in summer 4 cents per pound for the former, and 3, 4, or 5 cents for the latter. Of course, part of this is due to the same causes that have lowered the prices of all articles, but the greater part of the reduction was caused by the drag nets. They have thus far been rather a blessing than otherwise to the people of San Francisco.

Each boat engaged in crab fishing has 12 nets, costing from $2.50 to $3 apiece.

Preservation of apparatus.—All the gill nets, trammel nets, paranzellas, net ropes, trawl lines, etc., are tanned. Tar is not used to preserve fishing gear. The business of tanning the apparatus is monopolized by one person, who has three large iron kettles in a dilapidated building; the latter (with accessories) is valued at $600. Each kettle has about 400 gallons capacity, and frequently all these are used for boiling the tan liquid in which the gear is immersed.

Bait.—Herring, smelt, sardines, and anchovies are chiefly used for bait by the market fishermen. When herring are abundant and cheap considerable quantities are salted in brine. Part of these are sold for food and and the remainder kept for bait.* The smelt is prepared for bait by cutting off its head, removing the viscera (including the dark peritoneum), scaling it, and taking out the backbone. This process leaves the two boneless sides of the fish, or slivers, which alone are considered suitable for bait. Fresh bait is preferred, and, when it can be had, from 500 to 1,000 pounds are taken on each trip.

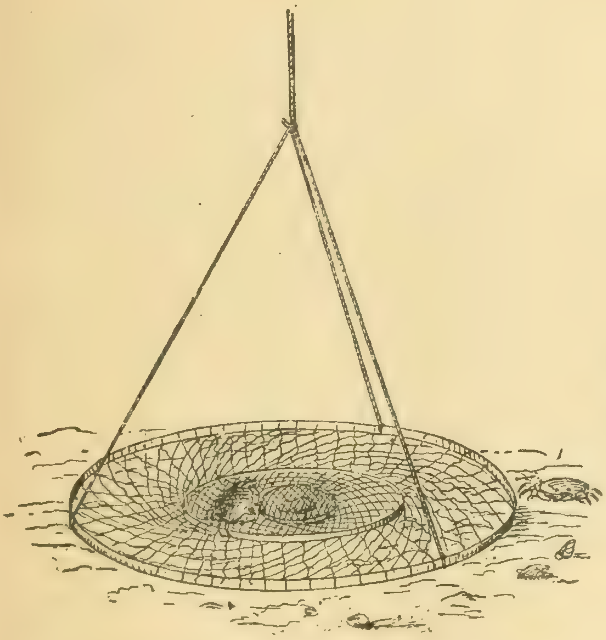


FIG. 1. Crab net set on bottom.

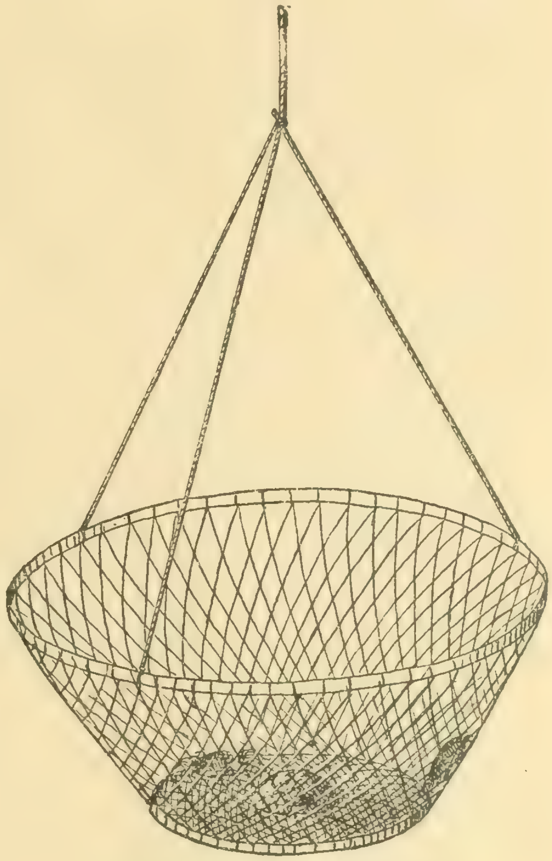


FIG. 2. Crab net drawn up.

Dr. Bean says that salmon roes are used for bait, and it is common to see a sign in the market as follows: "Salmon eggs for bait."

There is no complaint of scarcity of bait. Clams and squid are not in favor for this purpose. The fishermen think they are much less attractive lures than the species commonly used, and since they generally sell at remunerative prices there has been little reason for experimenting with them.

Marketing the products.—It may first be said that the wholesale fresh-fish business of San Francisco is practically controlled by a few firms, or dealers, who handle the best of the products and cater to the highest class of trade. In addition to their wholesale business, which em-

* The cod fleet take a few barrels of salt bait to begin with or to tide over any scarcity, but they usually depend upon getting their bait on the fishing ground.

braces the shipment of quantities of iced fresh fish to interior cities and towns, a retail trade is carried on from the stalls in the following markets: California market, Clay Street market,* New Clay Street market, Grand Western market, Central market, Bay City market, Center market, and Mission market.†

These are important markets, in which a large general assortment of provisions is sold. The fish stalls are generally provided with marble counters, and ordinarily present a neat and attractive appearance, while there are usually on sale many species to select from. While the list includes numerous kinds of fish, etc., the supply exposed for sale is not large, and considerable care is taken to keep the stock in as good condition as practicable in the refrigerators, with which each stall is provided. But, unfortunately, care and neatness are apparently not always prominent features of the San Francisco fresh-fish trade. The lack of these will be considered more fully farther on.

There are 15 wholesale and retail dealers in fresh fish and 25 engaged exclusively in the retail trade. Besides these, there are street venders, who hawk their wares from house to house. As a rule the business is carried on in a primitive manner, no records or books being kept.

Some of the marketmen are owners of boats and handle the bulk of fish taken by them; nevertheless, prices are said to be usually fair and satisfactory to the fishermen. Although combinations are often formed by the dealers to control the trade, they are seldom of long duration. In addition to the wholesale dealers, the small traders and peddlers (Italians, Portuguese, and Chinese) are among the purchasers.

---

* In 1889 Dr. Bean found that the rent paid for small stalls in Clay Street market was from $50 to $60 per month.

† A writer in the San Francisco Call (March 31, 1887) makes the following remarks concerning the so-called Wharf market:

"It is a rectangular shed, about 125 feet long by 50 wide. Mr. Scotto rents stalls to fishermen at 2 bits per man per week. All around the inner wall of the shed run fish-stands, with a passageway behind them. When the market is in full blast these stands are piled up with fish, sometimes in boxes, sometimes lying loose. On stands where there are no fish, nets are heaped; when daylight comes the fishermen will unroll these and mend them. In the middle of the building are more boxes and stands covered with soft-shelled crabs and fish. Around these, and lounging at the stands by the wall, are the fishermen and their customers, the Chinese predominating among the latter."

The description given above applies to the building at the head of the dock and the conditions which prevailed at the time the article was written. It is proper to say, however, that those conditions have materially changed. On the many occasions when Mr. Wilcox visited the market wharf and entered the building no fish were exposed for sale, nor were there any indications that the structure had been used for a fish market for many months. The stands were invariably piled with nets. At present it is customary for fishermen to sell their products directly from the boats and deliver them on the wharf to the purchasers. The buyers usually go on board of the boats to inspect the cargo and inquire the price asked by the fishermen. If terms are satisfactory a bargain is arranged and the fish are landed on the wharf.

The boats that go up and down the coast, or off to the fishing grounds, around the Farallones, some 35 to 40 miles distant, are generally absent from 2 to 4 days; but those that fish in the bays make shorter trips, usually marketing the catch of one day on the following morning. As soon as the fishing is over, the huge lateen sail is hoisted, the boat is headed homeward, and if there is a good breeze all the canvas that she will stagger under is kept upon her; or, if it is calm or the wind light, the swarthy crew toil away incessantly at the oars hour after hour until it seems they must fall down from utter weariness. No effort is spared to reach the market at the earliest moment, for any delay will result in the deterioration of the fish or loss of opportunity for selling them. No ice is used, and fish taken on distant grounds are too often not in good condition when they arrive. The start for market is commonly so timed that the boat may arrive about midnight, or early in the morning. Most boats reach their docks between midnight and sunrise, but generally a few belated ones come straggling in during the day.

It is an interesting and unique experience to stand on the pier in the midnight hours and watch the arrival of the market boats. Nothing disturbs the stillness except the ripple of the miniature waves caused by the brisk breeze and the lapping of the water upon the piling of the piers. Even the snort and puff of the steam tug, which is always so persistently nosing around in all corners of the harbor looking for a job, is no longer heard, and only the shadowy figures of "fish-hawkers," moving about near the head of the dock on the lookout for arriving boats and bargains in fish, give indications of life and wakefulness. Suddenly, in the hazy indistinctness of the night, we note, in the shadows cast by the hills that border the Golden Gate, a swiftly approaching object, dimly outlined and resembling the wing of a giant sea bird sweeping in from the ocean. Soon it looms into plainer view, and beneath the great breadths of canvas that stand out hard and unyielding in the stiff breeze, we see the dark hull of a fishing felucca, buried to her gunwale on the lee side, and rushing swiftly along through the water. How proudly she sails! Not a halyard or sheet is touched; not a move on board indicates preparation for shortening sail. We wonder what will happen as she comes tearing along for the pier-head; and now she is so close that disaster seems inevitable. But at this instant the hoarse-toned orders of the skipper ring out in quick succession and startling distinctness on the quiet night. Men run swiftly about the boat's deck; we hear the sharp rattle of sheaves, the rush of cordage; her long yard descends quickly to the deck, the lateen sail falls in graceful folds, while the jib disappears as if by magic; the dexterous hand of the helmsman moves the tiller at the right moment, and on comes the boat, sweeping gracefully into the narrow entrance to the dock, and a moment later she lies quietly alongside the pier, where her crew has placed her in a berth to land her cargo.

But others follow; and as we again look out upon the waters, boats may be seen approaching from up the bay, or from the sea, all leaning to the breeze under a cloud of canvas, their long, tapering yards and the lofty peaks of the lateen sails bending to the strain. And so they come, till the rising sun appears above the eastern hills across the bay, by which time most of the fleet lie snugly moored in dock.*

The wharf sale usually begins about 2 or 3 o'clock in the morning, but on Friday it commences as early as 1 o'clock. In each case it continues until the fare of the last boat is sold, unless the glut of fish is so great that the entire catch can not be disposed of. Generally, however, most of the fish are sold early, and at daybreak loaded fish vans are on their way to the large markets or shipping houses, or have already arrived there; the cry of "fresh fish! fresh fish!" may be heard from many pedestrian street hawkers, while the unmusical "toot, toot" of fish-horns announces the presence of fish-peddlers' wagons in the distant sections of the city and suburbs. Down in Chinatown "moon-eyed" fish-venders hawk their wares about through streets and alleys and shout their peculiar cries in their native tongue.† These generally have a yoke across their shoulders, from each end of which depends a basket containing the fish. Soon the retail markets are open, and few buyers are abroad before they can be accommodated.‡

But while the daily arrivals of fish are generally promptly disposed of, it nevertheless often happens that large catches may temporarily glut the market and render it difficult to sell at any price. As a rule, the fishermen quickly dispose of their products to the dealers or hucksters. The sale of herring and some other of the more abundant species is, however, often left to agents who sell on the wharf. When the market is overstocked by the arrival of thirty or more cargoes of fresh herring, the fishermen have a coöperative arrangement for regulating the sale, so that all may fare alike and no more fish be offered than can be disposed of.§ The crew of each boat fills a box holding 80 pounds of fish, which is placed in the hands of the agent, who, when he has

* Each boat, when engaged in fishing, pays a stated sum for dock fees, assessments being made weekly when the boats are at work. The rates vary in proportion to the number of men, as follows: Boats with 5 men, $1.25 a week; with 3 men, 75 cents; with 2 men, 50 cents; and with 1 man, 25 cents. The boats, however, can remain in dock without charge when not engaged in fishing. This is nearly the same as a classification by size of the boat, and Alexander states it that way, saying that "a 31-foot boat pays $1.25 per week; the next in size (23 feet) $1, and one 18 feet long, 75 cents." This entitles them to all the privileges of the wharves and buildings.

† Dr. Bean says the Chinese are good customers of the market fishermen, since they pay extra prices for choice fish. The red-tailed perch is a special favorite with them and they often pay three times as much for it as for other species.

‡ Alexander estimates that 350 men are employed in marketing fish in San Francisco, including the street peddlers and proprietors of small stands.

§ A writer in the San Francisco Chronicle (already quoted) says: "Each boat has a representative in the market, and every Saturday night he divides the proceeds of the week's sales among his partners."

sold the first installment, has the boxes refilled. This stops competition and obviates much loss that otherwise would result to the fishermen.*

Care of the fish, etc.—In no other respect is change and improvement so imperatively demanded in connection with the market fishery as in the care of the products. The best interests of all are concerned in this; for improvement in this direction will materially benefit fishermen, dealers, and consumers. Complete success can only be attained by the utilization of all available resources and a proper appreciation of the needs and desires of the consumer. Obsolete European methods can not long meet with even passive favor in this country. San Francisco especially, with such an immense wealth of fish to draw upon † and fishing grounds at her very doors, should not only have a great variety of marine products for food, but should have those products placed before the consumer in the best possible condition. The consensus of statement, however, shows a very different condition of affairs in this respect from that which should exist. The most careful and conservative observers admit the necessity for change, while pages might be filled with quotations from newspapers relative to "bad fish" in the markets.‡ Published statements of this character are very injurious to the fishery, and it is to be regretted that they are in any manner justified. This matter should be seriously dealt with. The prosperity of the fishery depends in a large measure on the adoption of such methods as will tend to disarm criticism and to improve the demand for fresh fish, and at the same time relieve the fishermen from loss now frequently incurred through delay in reaching the market.

At present tight-bottomed boats are exclusively employed; the fish are not eviscerated but are thrown in bulk into the hold or left on deck with perhaps a piece of canvas spread over them to keep off the sun's rays. No ice is used, and in warm weather deterioration is rapid, all the more so because the viscera soon begin to ferment and decay. Under favorable conditions the fish caught in San Francisco Bay and adjoining bays reach the city in good order. But even here some of the grounds are 15 to 20 miles distant, and calms often delay arrivals for many hours. The boats that go out to the Farallones, to Bodega Head, or Drake's Bay, or down the coast toward Santa Cruz, are necessarily much longer in reaching the city even under the most favorable circumstances, while light winds or calms (which often prevail) may

* On some occasions, when the market is so overstocked with herring that sales can not be effected at paying prices, a portion at least of the surplus is sometimes disposed of for smoking, and afterwards packed in small boxes of 5 or 10 pounds each, similar to the smoked herring put up on the Atlantic coast.

† On October 1, 1889, Dr. Bean recognized 40 different species of fish in the Clay Street market. These were chiefly the rock-cods, salmonidæ, pleuronectidæ, sciænidæ, and viviparous perch.

‡ There seems to have been an effort to control this matter by the authorities. Dr. Bean says an officer makes a daily inspection of the markets and condemns any fish he finds unfit for food. Cart loads are daily thrown away at the foot of Seventh street.

make it impossible for them to arrive there until their catch is in an advanced stage of deterioration. The result is that either an unwholesome article of food is put on the market, much to the ultimate injury of the fishery (by destroying confidence and decreasing the demand for fresh fish), or else the fishermen must throw their catch into the sea.

The next point for consideration is the method of handling fish after they have been landed. Although there has been some change in this respect in recent years, and some of the better class of markets are well conducted, there is, nevertheless, much room for improvement. Eminent authorities agree in saying that "the bulk of the catch exposed for sale is stale and often repulsive-looking." The small dealers and street hucksters usually buy the cheapest material, and a majority of them use little or no ice. I have learned of instances where the peddlers did not even have a covering of any kind for their fish. Under such circumstances it is not difficult to believe that the condition of a wagonload of fish might soon become exceedingly repulsive, even though they were fresh when landed. But their condition must be additionally disgusting if they had already become somewhat stale before the boats arrived. One who has had excellent opportunities for observing this phase of the business expressed his surprise that any person would purchase from a cart fish covered with dust, their skins parched by the sun, their eyes sunken, and with myriads of flies swarming over them; and it has been remarked that "the manner in which fish are handled, generally taken care of, and presented to the purchaser, does not impress one with the idea that cleanliness is one of the main objects of the business." If these statements are not exaggerated (and instances of this kind are not uncommon), it must be conceded that improvement can not be inaugurated too soon or maintained with too great care; I prefer to think such cases are exceptional.

It is not necessary to dwell upon this matter longer. It is enough to know that all experienced and unbiased observers concur in opinion and assertion. The important question then, is, How shall this evil be remedied? It is at least feasible to offer suggestions that may materially improve present conditions. First, boats that are engaged in line or paranzella fishing can, at small expense, be fitted with wells for bringing in their catch alive, or at least the bulk of it. The fish not immediately sold could be transferred to live-cars and left with agents to dispose of in the absence of the boats. No part of the catch would be lost, and, since the fish would be alive, the consumer would be sure of getting them in the best possible condition. This would inspire confidence and increase the demand enormously. The larger fish—rockfish, cultus-cod, etc.—that can not be brought in alive should always be eviscerated as soon as practicable after being caught. If this is done, and the fish are well washed, they will keep much longer and better, and will be good food. The smaller species, like smelts, herring, and flounders, would also be vastly improved by evisceration

and washing, but this is, perhaps, less necessary. If customers would refuse to buy fish that have not been gutted, and, for that reason, can not be closely examined to ascertain their exact condition of freshness, it would do much to correct the present undesirable condition of affairs.

It has been claimed by fishermen and dealers that they can not sell eviscerated fish, because the buyers believe that only stale fish are dressed. This is purely an idea imported from southern Europe, and a brief time would suffice to disabuse people's minds of such impressions.

Small, swift steamers, adapted to fishing and towing boats in calm weather, could undoubtedly do good and profitable service. They might also act as carriers and bring to market daily and quickly the catch of fleets fishing at the Farallones, about Drake's Bay, and in the more distant parts of San Francisco, San Pablo, and Suisun Bays. Indeed, some of them might be fitted with wells for keeping fish alive. Ice should be carried and used on the boats if it is feasible. With the present facilities for manufacturing ice, it ought to be produced at a figure that would make it available to all, and the improvement in the fish would doubtless repay considerable expenditure in this direction. Probably the establishment of cooling houses or refrigerators, such as are in operation in the eastern cities and on the Great Lakes, would prove profitable and advance the present condition of the fish trade.

All fish markets should be kept in a neat and tidy manner. Ice should be liberally used. Fish carts should be constructed so that their contents can be covered, and at least a small amount of ice should be used on them. No one is so much benefited as the fishermen by any improvement of this nature; for whatever adds to the attractiveness of goods offered for sale invariably increases the demand and adds to the profit of the producer. At the same time the salesmen and general public are gainers.

The effect of improved methods upon the distribution of fresh fish to the interior is a matter for special consideration. It is stated that the railroads and the express companies of the Pacific coast have signified a desire to make liberal concessions to build up the trade, to the extent, at least, of offering to transport iced fish and charging only for the actual weight of fish carried (no charge being made for weight of ice and boxes), and returning all empty packages free of cost to the shippers. The transportation facilities are good, and San Francisco ought to supply an immense area with fresh fish of many kinds. Pacific salmon reach all the Eastern and Central States, and why should not other valuable species do nearly as well?

Effects of Chinese traps and sea lions.—The market fisherman complain of the trouble caused by the trap nets set in the bays by Chinese fishermen. These are generally set upon stakes which come to the surface of the water. Drift nets are often caught and torn upon these stakes, and in some cases the damage is considerable. Much annoyance and some loss are caused by the sea lions that gather in numbers

on the "seal rocks" just outside of the Golden Gate, and which roam all over the bays and ascend the Sacramento River as far as Rio Vista. These active and voracious animals are very bold and seem to have learned the habits and methods of the fishermen. They will follow the boats and wait around them until the nets are set. As soon as fish are gilled they are immediately seized by the sea lions, which, in addition to robbing the fishermen, often damage the apparatus materially. It is common for these animals to seize a salmon when the nets are being hauled, and fight and struggle with the fisherman for its possession with such determination that the net is usually torn and the sea pirate secures his booty.

While the damage to nets is considerable and the daily consumption of fish by these pinnipeds is enormous, the fishermen believe that the sea lions exert even a more baneful influence by preventing schools of fish from entering the bays. Many persons have thought that they had a marked influence in causing the reported scarcity of fish in San Francisco Bay. Under these circumstances it goes without saying that, were it not for the State law that protects the seals, the fishermen would soon attack their rookeries and materially reduce their numbers or destroy them altogether. But, while seals and sea lions consume large quantities of fish, many old citizens assert that these animals are far less numerous than formerly, when fish were very abundant, and they maintain that there is some other cause for scarcity of fish if such exists. As late as 1874 there was a rookery at Mountain View River, St. Clair County, where at present seals are seldom seen, while they generally gather in large numbers at Redwood Creek and various other places in the bay.*

Extent of the San Francisco market trade.—Records are not generally kept and it is impossible to tell the exact amount of fresh-fish products sold in San Francisco by hucksters and marketmen, including quantities handled by wholesale dealers who ship to other cities and the trade generally. A careful estimate, however, based upon the experience of the most observant and conservative dealers and upon the records of transportation agencies, gives the figures in the following table:

Summary of the fresh-fish trade of San Francisco in 1888 *and* 1889.

Species.	1888.			1889.		
	Pounds.	Average price.	Retail value.	Pounds.	Average price.	Retail value.
Fish.						
Anchovies	200,000	$0.03	$6,000	120,000	$0.05	$6,000
Barracuda	125,000	.08	10,000	110,000	.10	11,000
Bonito	50,000	.04	2,000	80,000	.05	4,000
Carp	100,000	.07	7,000	60,000	.08	4,800
Catfish	10,000	.17	1,700	12,000	.10	1,200
Cultus-cod	187,500	.08	15,000	100,000	.08	8,000
Eels	1,000	.30	300	700	.30	210
Flatfish	483,000	.09	41,470	360,000	.10	36,000

* At the time of completing this report (1890) sardines are reported so abundant in San Francisco Bay that they literally obstruct the passage of boats through the water.

Summary of the fresh-fish trade of San Francisco in 1888 and 1889—Continued.

Species.	1888. Pounds.	1888. Average price.	1888. Retail value.	1889. Pounds.	1889. Average price.	1889. Retail value.
Fish.						
Herring	2,612,000	$0.05	$130,600	1,600,000	$0.06	$96,000
Kingfish	40,000	.06	2,400	30,000	.08	2,400
Mackerel	25,000	.10	2,500	30,000	.12½	3,750
Mackerel, horse	100,000	.08	8,000	125,000	.08	10,000
Mackerel, Spanish	100	1.50	150	100	1.50	150
Perch, fresh-water	432,000	.12½	54,000	425,000	.12½	53,125
Perch, salt-water	220,000	.08½	18,700	200,000	.09	18,000
Pike	20,000	.06	1,200	18,000	.07	1,260
Pompano	3,500	.80	2,800	2,500	1.00	2,500
Rockfish	860,000	.08	68,800	540,000	.10	54,000
Salmon	3,300,000	.06⅖	211,200	3,100,000	.06¾	209,250
Sardines	40,000	.05	2,000	800,000	.04	32,000
Sea bass	350,000	.06	21,000	400,000	.06	24,000
Shad	75,000	.10	7,500	....	....	....
Skates	40,000	.03	1,200	75,000	.05	3,750
Smelts	850,000	.08	68,000	820,000	.08	65,600
Striped bass *	....	....	....	1,000	1.00	1,000
Sturgeon	460,000	.06	27,600	495,000	.06	29,700
Suckers	175,000	.02½	4,375	150,000	.04	6,000
Tomcod	8,000	.12½	1,000	5,000	.15	750
Trout, lake	50,000	.20	10,000	40,000	.25	10,000
Trout, brook	2,000	.30	600	1,200	.30	360
Miscellaneous	29,000	.07	2,030	23,000	.06½	1,495
Total	10,848,100	....	729,125	9,723,500	....	696,300
Mollusks, crustaceans, etc.						
Oysters .... bushels	130,000	3.90	509,175	150,000	3.90	585,000
Clams, hard-shell .... sacks	1,500	3.00	4,500	1,200	3.00	3,600
Clams, soft-shell .... boxes	31,200	1.50	46,800	18,500	1.00	18,500
Mussels .... buckets	43,800	.50	21,900	35,000	.50	17,500
Crayfish .... pounds	25,500	.09	2,250	38,400	.07½	2,880
Crabs .... dozens	77,800	.98	76,244	77,600	.98	76,048
Shrimp .... pounds	290,000	.08	23,200	175,000	.08	14,000
Prawn .... do	25,000	.20	5,000	20,000	.20	4,000
Squid and octopus .... do	25,000	.08	2,000	15,000	.08	1,200
Terrapins .... dozens	1,000	3.00	3,000	1,200	3.00	3,600
Turtles .... pounds	25,200	.05	1,260	28,000	.05	1,400
Frogs .... dozens	4,000	3.00	12,000	4,500	3.00	13,500
Total	....	....	707,329	....	....	741,228
Grand total	....	....	1,436,454	....	....	1,437,528

* Striped bass have recently been taken in such quantities that the price has been reduced to 18 cents a pound.

FISHERIES OF TOMALES BAY.

The fisheries of Tomales Bay (including settlements in Marin and Sonoma Counties) may properly be included with the market fisheries of San Francisco, as the products go chiefly to that city.* This bay is a long narrow inlet nearly parallel with the seacoast, and extending southward about 17 miles from its mouth. It is bordered on each side by rather high hills, and is of nearly uniform width; its entrance is about 45 miles (by water) from the Golden Gate. Papermill Creek

* The fisheries at Sausalito, Marin County, are really a part of the market fishery already described, in all that relates to boats, apparatus, methods of capture, marketing the catch, etc. The Chinese fishery camps at San Quentin, Point San Pedro, etc., in the same county, are discussed in a special chapter. Fisheries on the "bay side" of Sonoma County are considered under appropriate headings. It is, therefore, not advisable to follow county lines in dealing with the fisheries of Tomales Bay and vicinity, since it would involve repetition or a lack of clearness.

enters the head of the bay. This stream is quite celebrated for trout fishing in spring; a few salmon also run into it.

The bay is noted as a fishing ground, and its upper part is so near Drake's Bay, another excellent locality for fishing, that boats and apparatus can readily be transported across the narrow neck of land dividing them. The fisheries of the region are vastly benefited by the railroad that skirts the eastern side of the bay, passes through the small settlements, and affords important facilities for the rapid transportation of the products to market. The southern terminus of the road is at Sausalito, on Richardson's Bay, where it connects with a ferry running to San Francisco.

Fishing centers, etc.—The principal fishing centers are Bodega, Freestone, Fisherman's, Marshall, Hamlet, Tomales, and Point Reyes; these are railroad stations on or near the shores of the bay and therefore convenient as shipping-points. Large quantities of fish are shipped to San Francisco (by express) from several of these stations. In 1888 88,440 pounds went from Fisherman's, 68,472 pounds of fish and 46,095 pounds of clams were sent from Marshall, while the shipments from Hamlet amounted to 95,945 pounds of fish. The species sought are practically the same as have been mentioned. Fish are abundant in Tomales Bay in their seasons, more particularly smelt, perch, herring, and sea bass; there are only a few salmon, and flounders are not numerous. The bulk of the catch is smelt and herring.

Clams of two species are abundant on the shores of the bay; one is the round hard-shelled *Tapes* and the other a large soft-shelled species; only the former is utilized. Oysters have been planted at the head of Tomales Bay; they did not thrive, and were ultimately taken up and the beds abandoned; oyster-shells occur in places in the bay, and some think natural beds may yet be found as a result of the planting referred to. Some years ago an attempt was made to carry on a frog farm, but the enterprise did not prove successful.

Sea lions and seals follow the schools of herring and smelt into the bay, and are plentiful and active, but are seldom or never seen at other times.

Boats and apparatus.—The fishing boats at Tomales Bay are generally from 17 to 20 feet long; they usually carry centerboards; some are sharp aft and others have square sterns. A sprit rig is generally used. One of these had the following dimensions: Length, over all, 20 feet; beam, 5 feet 10 inches; width of stern, 3 feet 8 inches; mast stepped 3 feet 8 inches abaft upper end of stem. They are not designed for service outside of the bay, and seldom go out into the ocean. If it is necessary to work in Drake's Bay, the boats are usually hauled across the narrow strip of land that separates the head of Tomales Bay from the seacoast. The only loss of life here in ten years was in 1887, when two fishermen were overtaken by a storm, which swamped their boat while attempting to reach Drake's Bay by the ocean. Drag seines and gill nets are the principal apparatus of capture.

Methods of fishing, shipping products, etc.—The methods of fishing are similar to those already described under the head of market fishing. The seines are operated from shore, and the gill nets are set in the ordinary manner, both as set and as drift nets. The bulk of the fish are shipped to wholesale dealers in San Francisco, who sell the products on commission to other dealers or hucksters, or ship them to the interior or to towns across the bay. For transportation, the fish are packed, heads up, in long wooden boxes about a foot deep with an average capacity of 125 pounds. Instead of using ice, wet sacks or gunny cloth are placed over each box to keep the fish moist. The nets are generally hauled early in the day and shipments made by the morning train, so that the fish reach the city a few hours after being caught.

Men, women, and children dig clams, but only the men (native Californians) engage regularly in this fishery. The average number of men employed in 1888 was 20. The clams are sold to the local dealers for $1.50 per sack of 70 pounds (4 wooden bucketfuls), the fishermen being paid in merchandise. The clams are emptied into bins built on the edge of the bay, and usually 75 to 100 bushels are kept on hand to supply orders from San Francisco.

The following tables show the extent of the fisheries of Tomales Bay in 1888; but these figures, as well as those for Russian River, are included in the general tables for San Francisco Bay and vicinity:

Persons employed.

Country.	Nativity.	Nationality.
United States	20	27
Austria	11	11
Portugal	2	1
Italy	22	16
Mexico	1	1
Total	56	56

Apparatus.

Designation	No.	Value.
Boats	21	$6,300
Gill nets	210	5,920
Seines	16	2,000
Total		14,220

Products and values.

Products.	Pounds.	Value.
Salmon, fresh	20,000	$1,000
Other fish, fresh	327,707	15,885
Clams	81,915	2,048
Total	429,622	18,933

FISHERIES OF RUSSIAN RIVER, SONOMA COUNTY.

Russian River is about 100 miles in length and 75 to 150 yards wide over the principal part of its course. It empties into the Pacific 6 miles below Duncan's Mills. This settlement is a railroad station and shipping-point for fish other than those used locally. The only shipments of river-caught fish in 1888 were sent from this place.

Species, importance of fisheries, etc.—The river is well supplied with carp, pike, suckers, hardmouths (*Acrochilus alutaceus*), and sturgeon. Trout are numerous in the upper reaches and in some of the small tributaries that empty into the river near Duncan's Mills. In the spring of 1889 they were unusually plenty. During the fall and spring there is a run of "winter" salmon weighing from 8 to 20 pounds each. The principal fishing ground is the section of the river from its mouth to Duncan's Mills, about 6 to 8 miles.

This river is now rather unimportant as a commercial fishing center. At one time it was noted for the abundance of salmon in season; but injudicious and illegal fishing has materially reduced their numbers; and it is said that the decrease is generally apparent from year to year. In 1888, however, salmon were more plentiful than for several years, and the fishery for them was temporarily increased in importance. The river fishery derives its chief importance from the quantities of fish locally utilized, which amount to nearly five times as much as those shipped to market by express. In 1888 the local consumption of fish was estimated at 150,000 pounds, while only 33,597 pounds were shipped to San Francisco.

Fishermen.—There are only 15 professional fishermen; 10 of these are Italians and 5 are Portuguese. Besides these there are many people living along the river who fish at odd times to supply their own tables, disposing of any surplus to their neighbors, or in some cases peddling part of the catch through the country. The quantity of fish taken this way is considerable, and often a man may obtain a year's supply in a short time. But the irregular character of these operations, the sparseness of the population, and other causes make it impracticable to do more than to present estimates of the products and values.

Catch, etc.—From 75,000 to 100,000 pounds of salmon are taken for local consumption by those living along the river. The professional fishermen take from 20,000 to upwards of 30,000 pounds of salmon annually, constituting the bulk of the shipments; they also catch from 75,000 to 150,000 pounds of other fish, which are mostly disposed of locally or peddled through the adjacent country.

Apparatus, etc.—Gill nets are the principal form of apparatus, and these, particularly those used for the capture of salmon, are often smaller in the mesh than the laws of California permit to be operated. They are set in the usual manner.

Illegal fishing.—It is claimed that for several years past there has

been much illegal fishing, and many believe that this has caused the scarcity of fish, especially salmon. Sometimes arrests are made, and for a while this action generally has a marked effect. In 1888 the "fishermen were reaping a rich harvest with their fine-meshed nets." These were set continuously to such an extent that the fish had little chance to ascend the river. No regard was paid to the requirements of the law. Finally, when some 20,000 or 30,000 pounds of salmon had been caught, all of the fishermen were arrested (January, 1889) and fined from $50 to $100 each. For several months, at least, this action had a decided influence on the river fisheries; professional fishermen were scarce or less active than formerly, and nets were not seen on the river. Those familiar with the facts believe the bulk of fish sent to San Francisco in 1888 were taken illegally.

Shipments.—The amount of fish shipped to San Francisco by the Wells-Fargo Express during 1888 is given below in detail by months. This statement will show the periods when salmon are taken. No shipments were made in the months omitted from this list.

Months.	Pounds.
January	14, 077
February	3, 785
April	250
May	200
October	650
November	8, 485
December	6, 150
Total	33, 597

The following statistics given here apply only to Russian River and do not include other fisheries of the county. The statistics of the settlements in this county bordering on Tomales Bay have been combined with those of towns in Marin County to show the extent of the industry on that bay.

Statistics.

Persons employed (nativity and nationality):	
Italians	10
Portuguese	5
Apparatus:	
33 boats	$2, 350
110 gill nets (40,000 feet long)	3, 000
Products and value:	
33,597 pounds of fish shipped	2, 016
150,000 pounds of fish consumed locally	9, 000

CHINESE FISHERIES.

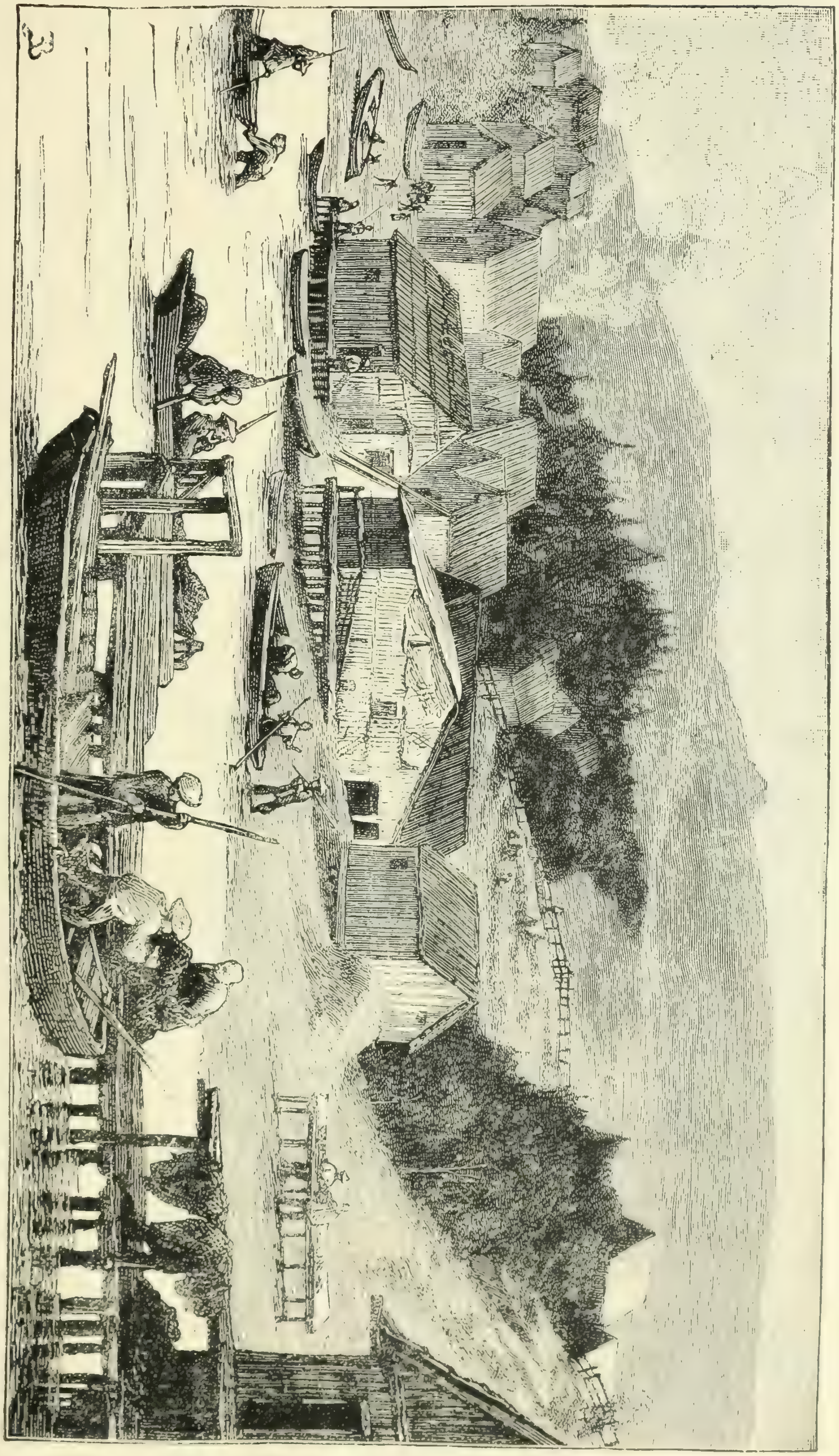
Although the Chinese fishermen engage in the capture of a variety of species in San Francisco Bay, an effort will be made to present the facts in such a manner that the details relating to any special branch of the fisheries pursued by them will be clearly understood. The sta-

tistics given are estimates based upon the statements of those most familiar with these fisheries, including some of the Chinese, and upon a careful and intelligent consideration of the exportations of fishery products by this race, and the quantities disposed of for immediate consumption in the local markets, including San Francisco. While this is not entirely satisfactory, it is practically certain that the actual facts have been closely approximated.

For several reasons there was great difficulty in obtaining reliable statistics from the Chinese fishermen of this region. First, it was impracticable for either Wilcox or Alexander to visit the camps during the height of the fishing season; their visits were unavoidably made "between seasons," when comparatively little fishing is done, and when the camps are deserted by a large percentage of the fishermen, who seek employment elsewhere in winter. Second, the Chinese apparently have no idea of keeping accounts. Third, they are seemingly disinclined to discuss or to relate what they have done, evidently apprehending some purpose on the part of the investigator to get them into trouble. Feeling that they are opposed by all white men, and dreading ill treatment at the hands of the legal authorities or others, they are naturally suspicious and distrustful of the motive of inquiry, and are disposed to be reticent; this, together with the lack of familiarity with the language, the best of them being able to speak only a jargon of "pigeon English," renders it practically impossible to get intelligent and accurate statements from them. In many cases, however, much important information was obtained by a system of cross-questioning adroitly adapted to the circumstances.

So far as the size, character, etc., of the apparatus and boats are concerned, the data were obtained with great care and exactness; the measurements were made on the spot, and whenever practicable the boats, camps, etc., were photographed. Indeed, all possible sources of information were utilized, and it is therefore believed the data collected are as accurate as it is practicable to obtain unless one could live at the camps during the fishing season.

Fishing camps.—The Chinese fishermen do not affiliate with the market fishermen of San Francisco Bay, but form colonies or settlements of their own race, which are located near the fishing grounds. These "camps," as they are universally called, are composed of an aggregation of rude shanties and other needful accessories, such as drying-frames, etc., packed close together near the water. They are devoid of all suggestion of comfort or cleanliness and afford only the most meager quarters to these industrious people, most of whom find here only a temporary residence, and live in miserable squalor in their rickety and filthy huts. There are several of these camps on San Francisco Bay. These have incidentally been referred to under the head of "fishing centers." Four are located on the south side of the bay, at Hunter's Point (Point Avisadero on the map), Point San Bruno or



CHINESE CAMP, SAN FRANCISCO BAY.

"China Point," near Point San Mateo, and at the mouth of Redwood City Creek. At the north are the camps at Point San Quentin, Point San Pedro, and in San Pablo Bay, on the west side, and a mile or so south of Point San Pablo, on the east side of San Francisco Bay.

Species, etc.—Shrimp are caught in immense quantities by the Chinese, who have a practical monopoly of this fishery. Three species of shrimp are taken for food in San Francisco Bay, the *Crangon franciscorum*, *C. vulgaris*, and *Hippolyte brevirostris*. The former is the most important in the San Francisco markets, and excels in size all other species of shrimp on the Pacific coast of the United States. It is especially abundant in the region under discussion, particularly in San Francisco and Tomales Bays. *Crangon vulgaris* and *Hippolyte brevirostris* are much less numerous and not so large. They are taken with the other species, and constitute a small percentage of the catch.

Sturgeon and flounders are the principal fish taken by the Chinese, but nearly all kinds that frequent the waters of this region are caught by them. They capture great quantities of young fish, of which more extended mention will be made in a subsequent paragraph.

The soft-shell clams sold in the San Francisco markets are mostly taken by the Chinese.

Fishing grounds.—Practically the whole of San Francisco and San Pablo Bays constitutes the fishing grounds of the Chinese. The localities where they most commonly set their bag nets are shown on the map (plate VI); these are generally conveniently near their camps and where shrimp are known to be plentiful. Gill nets, seines, sturgeon trawls, fykes, etc., are also used, either to obtain the best results or to secure secrecy, since the Chinese commonly use illegal forms of apparatus.

Apparatus.—The apparatus varies in character, is exceedingly destructive of minute forms of marine life, particularly young fish, and is generally distinctively oriental; some is imported from China, but a large portion is made by the fishermen in winter.

Bag nets, gill nets, fyke nets, and sturgeon trawls are the principal forms employed. The bag net or "trap" is most in favor; it is extensively used in certain parts of San Francisco Bay and adjacent waters and is chiefly relied upon for the catch of shrimp.* This net is a great cone-shaped sack or bag, 42 feet long from mouth to apex, 24 feet wide at the mouth, and 4 feet wide at the bottom or point of the cone, which, when set, is tied up with a puckering-string or "sphincter," like the cod end of a beam trawl. When the net is hauled the string is unloosed and the contents of the bag are dropped into the boat. The

* This form of apparatus has been erroneously mentioned as a seine or "drag net" by some writers, though it is evident from the manner in which it is commonly operated that those names have been misapplied. I have failed to find any reliable information that it is ever used to haul shrimp on shore or that it is dragged over the bottom like the paranzella.

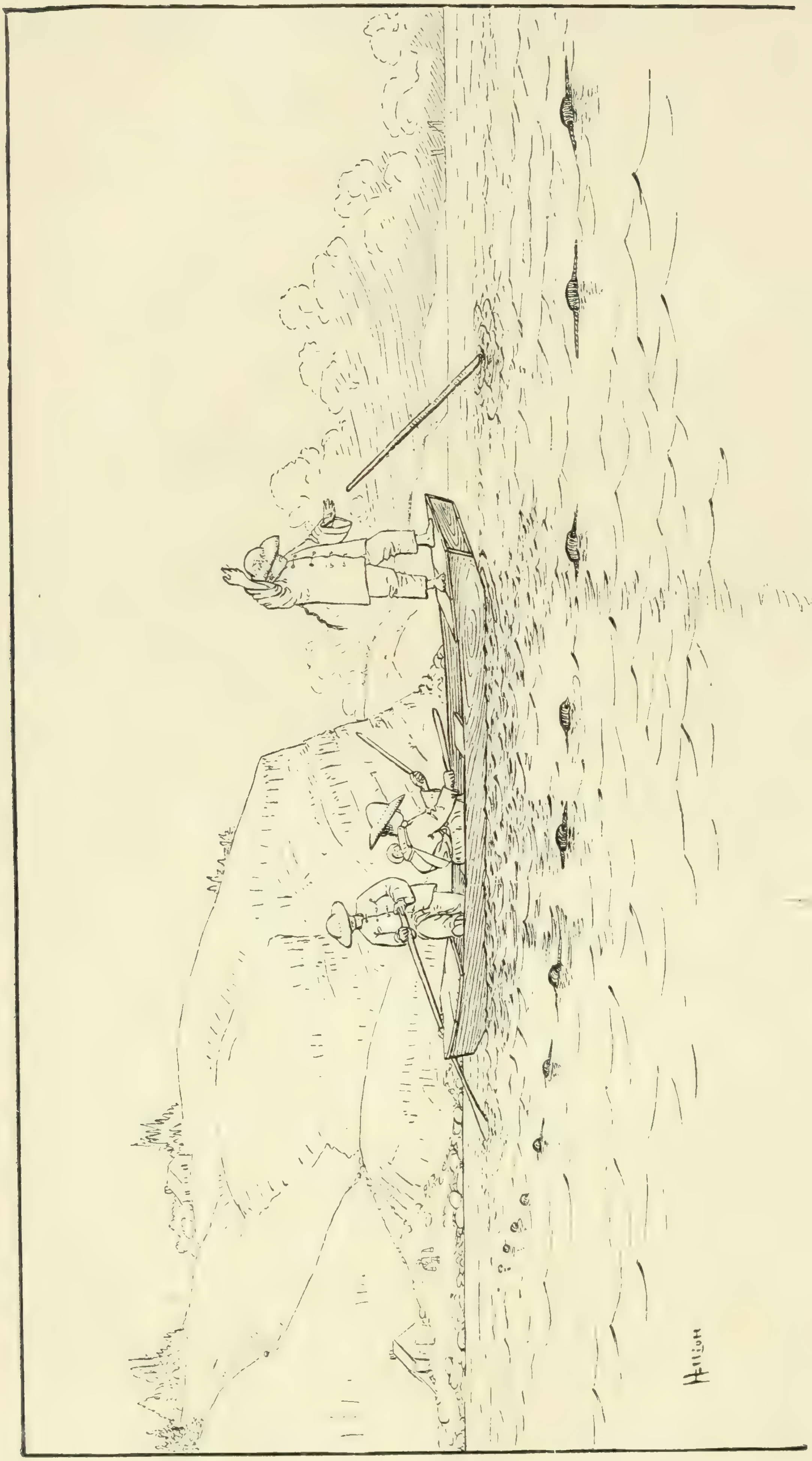
bags are made of hemp twine. The half of a net next the mouth has a 2-inch mesh; the middle section, of about 10 or 12 feet, has a 1-inch mesh, while the lower or small end has a mesh measuring only one-half inch. Considering the contraction caused by tying up the small end of the bag, it will readily be seen that scarcely any marine life is minute enough to pass through the meshes. Wilcox saw one of these nets at San Quentin which had been imported from China, and it differed from the above only in width, it being 30 feet wide at the mouth and 18 inches wide at the small end. The mouth was oval or oblong in form, and when set would be about 6 feet deep. It had a row of floats or corks along the upper edge, and sinkers were fastened to the lower side of the mouth to keep it open. This net cost $12 in China, but the freight and import duty added materially to this amount.

While some of these net bags are imported, the majority are made by the fishermen during the season when they can not do much fishing. In December, 1888, Wilcox visited the camp at Hunter's Point; only a half dozen Chinamen were there, all of whom were busy making hemp nets for their traps, to be used the following spring. The seines and gill nets are similar to those employed by Chinese fishermen elsewhere on the coast, and need not be described in detail. The fyke net is of the ordinary pattern. Alexander makes the following remarks concerning its use:

> The fyke net is by far the most destructive apparatus used for the capture of fish. This net has been described too many times to give it more than passing mention here. That they are used in every available place along the coast whenever circumstances will permit is a well-known fact. That they are the means of destroying prodigious quantities of small crustacea and other small fry, such as large fish of commercial importance subsist upon, is acknowledged by all; but no steps have yet been taken which have had the desired effect of wholly preventing this wholesale slaughter. The enormity of using fyke nets would be greatly lessened if there were any possible chance for minute species to make their escape after entering them; but the meshes are so small that the finest floating substance is captured. The various species of floating fish eggs which are annually destroyed in this way must be enormous. If on hauling or taking up these nets any pains were taken to liberate the eggs captured the destruction to natural propagation would be greatly alleviated; but on the contrary everything which comes to the net of a Chinaman is "fish," and is utilized for his gastronomic wants.

The sturgeon trawl has been used for a long time in China, and the natives of that country have introduced it in the fisheries of California, though its employment is illegal. Alexander says of it:

> This is a very cruel as well as a destructive way of catching fish. Each trawl has an average of eighty barbless hooks, which are as sharp as needles. They are fastened to the gangings in clusters of eight and ten, and when in the water are swung about by the action of the tide like the tentacles of an octopus reaching out for prey. A fish which approaches within a length of itself is pretty sure of being hooked by one or more of these treacherous devices. When a fish of any considerable size gets fastened to a hook it is sure in its struggle for freedom to become entangled with other hooks, and finally, in its flouncing about, will become completely incased in a network of gangings and hooks, like a shark which has rolled



CHINESE GILL-NET FISHING. FRIGHTENING FISH INTO THE NET.

(Drawn by Henry W. Elliott.)

itself up in a net. There is no possible means of escape, and when thirty or forty sturgeons or other large fish are actively exerting themselves for liberty, and each struggle only tends to hold them more secure, the scene can better be imagined than described.

The wire of which the hooks are made is square, of the finest steel, and capable of holding fish of great size. The trawls are always set off bottom and from three to five fathoms below the surface, according to the depth of water and the way in which the fish sought are thought or known to be moving. Often large numbers will be set in one string, they being bent together in the same manner as cod and haddock trawls; they are also anchored and buoyed in the same way. Some sturgeon trawls have a small wooden float attached to each cluster of hooks; but I am informed that this is an Italian invention and is not used by the Chinese. The trawls used by the latter class of fishermen have the hooks fastened to short gangings which are attached to short bridles, these leading to the ground-line. The whole apparatus is indeed a complicated one, and in order to give a correct and comprehensive description in detail it should be seen set in the water, which, by the way, is something seldom witnessed.

Methods of fishing.—Generally speaking, the bag nets or traps are put into the water early in spring, and most of them are taken up in November, when the fishery practically ends, though a few nets are fished all the year. Wilcox states that when he visited the Chinese camps, in the last week of December, 1888, he sailed through San Francisco Bay in the steam-launch of the *Albatross* for a distance of fully 30 miles without seeing a single trap net in the water. The number used varies somewhat in different camps, but on the whole amounts to an average of five or six to a man. The nets are set in two ways: One method is to anchor them at the bottom, marking their positions by keg buoys floating at the surface. By the other method they are set in rows, the mouth of each fastened between poles driven into the bottom, with their upper ends projecting above the surface of the water. By this method the mouth of each net is fully distended, while the body of it swings away with the tide. All kinds of swimming animals that come in or go out with the tide are caught, for in some localities the bag nets completely cover the bottom across a wide area.

The nets are watched very carefully, and at each "slack" or turn of the tide they are taken up, the contents removed, and their direction changed, so that they will head the next set of the current and thus be prepared to take into their capacious pockets all that comes to them. The catch is secured, according to Wilcox, by taking up the mouth and tying up such part of the bag as can be easily handled; the contents are then emptied into the boat. Then another part is tied up and emptied, and so on, until the bag is cleaned of its contents, when it is once more set facing the return tide. Everything that enters these bag nets, large or small, is taken. The best fish are sold for food; the unsalable are fed to pigs or poultry. Shrimp are the most important part of the catch, both in quantity and value.

The gill nets are usually anchored, and are termed "set nets" when used in this way. The Chinese fishermen are very painstaking and lose no opportunity to secure a good catch. Having set their gill nets,

they will stay near by in their boats and watch for approaching schools of fish; if they see fish close to the apparatus, and not disposed to enter, as is often the case, they will dart oars into the water or pound on the boat's gunwale to frighten the fish, so that they will, in their wild rush to escape, plunge into the meshes of the nets (see plate XIX).

Illegal fishing, destruction of small fish, etc.—It is generally agreed that the Chinese fishermen have little regard for the law (if they can evade it) and absolutely no consideration for the preservation of young fish from destruction. "All is fish that comes to their net," in the strictest sense of the term, and the apparatus they use is specially designed to take the smallest forms of aquatic life. Complaints have been loud and numerous on the part of other fishermen, and efforts have been made from time to time by the State authorities to put a stop to illegal and destructive methods. Judging from all the information obtainable these efforts have been only partially successful. A writer in the San Francisco *Bulletin*, alluding to the marked and growing scarcity of fish in San Francisco Bay, says:

Another explanation which is now given is the ravages which the Chinese are making upon the young fish. Hundreds of these assumed despoilers of every blessing are employed constantly in catching the young fish, including every species in the bay, just developed from ova, in which work they employ fine nets, scoops, and other effective methods. This material is esteemed a prime delicacy among the heathen, large quantities being consumed in the city, and the business of preserving the young fish and shipping them to China has become an important enterprise. Thousands of young salmon, from 2 to 4 inches in length, may be found among the large supplies brought in daily to the fish shops in the Chinese quarters, and this is undoubtedly the true explanation of the alarming decline in the quantities of the best fish. The process continued for a few years will render salmon and other favorite species a rarity in these waters, and some enactment seems to be called for, to afford protection from this particular encroachment of the Chinese scourge.

The apparent bitterness of this statement might rob it of force were it not reiterated from various sources. This particular phase of the fishery has attracted the attention of every one who has taken any interest in the matter. Wilcox mentions the fact that at Hunter's Point he saw several basketfuls of thoroughly dried, broken fish scraps, among which was a large amount of whole fish (*Parichthys porosissimus*) not more than 1½ to 2 inches long.

Allusion has already been made to the destructive fishing with sturgeon trawls and fyke nets.

Regarding illicit fishing, Alexander says:

The Chinese put the authorities to more trouble than all the other fishermen combined, and hardly a week passes without some guilty Oriental being dragged before the court for illegal fishing. This class of people seem to take pride in transgressing all laws established by the State. They invariably fish with fyke nets and sturgeon trawls whenever they think such fishing can be carried on with impunity. Frequently they are captured and their gear confiscated. During the past year [1889] 47 sturgeon trawls and several fyke nets were captured. These methods of fishing are carried on to a considerable extent in the San Joaquin and Sacramento Rivers. The

Italians, too, are more or less guilty of fishing with prohibited apparatus, but they do not so persistently violate the law as the Chinese.

There seems to be no way of ascertaining the number of sturgeon trawls and fyke nets employed on the rivers and bays adjacent to San Francisco Bay; but, judging from the frequent reports coming from different sources, it is to be presumed that illegal fishing is followed considerably. The quantity and kinds of fish which the Chinese of San Francisco expose for sale and export would indicate that a large percentage of their food-fish are caught by illicit methods.

Preparation of products.—The curing of fishery products for exportation is carried on during the entire fishing season. The fish are dried in the same manner as has been noticed in discussing Chinese methods of curing elsewhere, and scarcely anything is too minute to be excluded. Quantities of fish from 1 to 2 inches in length are dried for exportation.*

Drying shrimp for China.

The special feature of curing is the preparation of shrimp, which appear to be the most important object of fishery to the Chinese on San Francisco Bay and adjacent waters. Wilcox states that the vats in which shrimp are boiled, as observed by him at several of the camps, are very primitive and quite different from those heretofore described.† He noticed that a hole was first scooped out of the side of a hill or steep bank for the fireplace, and in this is placed the boiling vat or tank supported on a rudely built base-work of stones. The vat was 6 feet long on top, 5 feet on the bottom, 3 feet 4 inches wide, and about 2 feet deep. It had wooden sides and ends and a sheet-iron bottom bent up

* Alexander says: "This work is sometimes performed in a very discreet manner, especially when an unusual amount of illicit fishing has been going on."

† The kettle for boiling the shrimp is a rectangular iron tank 6 feet long by 4 feet wide and 2 feet deep, with a fireplace underneath. (The Fisheries and Fishery Industries of the United States, p. 808: "The Shrimp and Prawn Fisheries of the Pacific Coast," by Richard Rathbun.)

at each end. The water is first brought to a boiling heat before the shrimp are put into the vat, and they are allowed to boil about 10 minutes. They are then spread to dry upon gently declining or level stretches of hard ground which has been previously stripped of grass and rendered perfectly smooth. The shrimp yard at Hunter's Point is about 15 acres in extent. The Chinese use a hoe-like broom to spread the shrimp and to turn them as occasion requires. After being thoroughly dried by 4 or 5 days' exposure to the sun, they are crushed under large wooden pestles or trod upon by the Chinese in wooden shoes for the purpose of loosening the meats from the outer chitinous covering. The shells are then removed from the meats by shaking the shrimp in a basket or by passing them through a winnowing mill.

Mr. Rathbun says:

This fanning-mill, which is rather a crude affair, is constructed of wood by the Chinese on precisely the same principle as the one used for winnowing grain. It measures about 8 feet long by 5 feet high, and consists of a square box divided on the inside for the passage of the separated shells and meats, with a hopper above, and a large fan wheel worked by a crank on one side.

Both meats and shells are then packed in sacks for exportation, though a small amount is sometimes reserved for local sale. All of the small and inferior kinds of fish are boiled, dried, and packed for exportation by nearly the same method used for curing shrimp.

Disposition of products, uses, etc.—The catch is partly used at home or sold at San Francisco or to the various inland Chinese settlements, but the great bulk of it goes to China. Shrimp shells have been utilized to some extent in California as a fertilizer, but nearly all of this material, like the meats, is exported to China, where it serves as manure for the tea plant, rice, etc. The usual price in San Francisco is 25 cents per 100 pounds. The meats are eaten by all classes in China, but are cheaper and less esteemed than native shrimps, which are comparatively scarce. Mention has been made of the utilization of certain products for feeding pigs and poultry. Shrimp, and also shrimp shells, are often fed to fowls, and are said to produce excellent results. They are broken up quite fine, soaked, and mixed with cracked wheat, oat meal, or corn meal.

Marketing.—The common custom is, at the end of each day's fishing, to carry a part of the catch, including fresh shrimp, to the San Francisco markets. The shrimp are transported alive in baskets; these are covered with netting having a central hole closed with a puckering string. The average price per pound of live shrimps is 10 cents; fresh fish fluctuate a good deal in value, and the price also varies with species. All that can not be sold in the market, or by hawking about the city, towns, or country, are taken back to the camps and immediately put through the process of boiling and drying for shipment abroad. Mr. Garibaldi estimated the value of shrimp sold at the Clay

Street market alone in 1879–80 at $2,000. The local consumption of shrimp amounts to about 300,000 pounds annually. In 1888 it reached 290,000 pounds, worth $23,200.

Exportation.—The export trade is entirely within the control of the Chinese merchants, who ship to the Hawaiian Islands and to Hongkong as a distributing center for China. It is impossible to determine accurately the amount of each species shipped from San Francisco by the Chinese, for many kinds are classed under one head. For instance, Alexander says that which comes under "codfish" in the records of the customs house is made up of cultus cod, red rockfish, flounders, sculpins, and various other species. That which is marked "other small species, shrimp, etc.," is composed of all kinds of small fish which the various devices known to those people will capture. Nor is it easy to tell precisely from what source the material is drawn; though it is less difficult to ascertain this, since certain species are taken in only particular localities and the records of transportation agencies are an important aid in solving this problem.

The tables showing the exportation of fishery products from San Francisco include such information as could be obtained from the customhouse records. A large percentage of the material exported is the result of the Chinese fishery, but includes the product of various other localities besides the region considered in this chapter.

The exports of shrimp should properly be credited to this region, and their consideration is a matter of interest. In 1887, 525,638 pounds of shrimp meats, valued at $58,698, and 1,752,718 pounds of shrimp shells, worth $16,468, were exported. In 1888 the exportations were 769,660 pounds of meats, valued at $76,966, and 3,842,200 pounds of shells, valued at $38,482.

THE OYSTER FISHERY.

Although the oyster business centering in San Francisco is thought to be only in its infancy, it has nevertheless assumed important proportions, the total value of the output in 1888 amounting to $509,175. It has naturally attracted attention, but, while its future is believed to be assured, its development is limited by conditions, natural or otherwise, tending to make the growth slow and to keep down the production to the actual needs of the market. At present there are only two firms employed in the business, and these were practically the pioneers in the trade.

The supply of edible oysters up to date is, according to the best authorities, largely dependent upon importation of "seed" from the Atlantic States. The native oyster (*Ostrea rufa*) of California is small, and has such a strong coppery flavor that it is comparatively little valued as food, and is not extensively eaten.

Soon after the opening of direct rail communication with the East,

about 1869, the firm of A. Booth & Co. brought to San Francisco three carloads of live Eastern oysters of large size. It is said that this was the first shipment of live oysters from the Atlantic coast. But, according to the traditions of the trade, the market was overstocked by even this small invoice; consequently, to avoid loss, the shippers had to plant in San Francisco Bay all that could not be promptly sold. This experiment, the first attempt at planting oysters on the Pacific coast that we have any record of, resulted favorably. The oysters lived and thrived, and those interested gained valuable experience from the enforced experiment, while the financial result gave them confidence to enter more extensively into the business.

The following year "seed oysters" were imported from the East and oyster beds were started on a commercial basis. About 1871 Booth & Co. sold out their interest to the Morgan Oyster Company, which largely increased the business, not only supplying the city and suburban trade, but sending to the interior of the State shipments of canned "fresh-frozen" oysters. In 1877 M. B. Moraghan engaged in the oyster business at San Francisco, and in 1878 he began to import seed oysters from the Atlantic coast, which were planted in San Francisco Bay. From time to time others have made feeble attempts to go into the business, and have located beds and planted "seed" on a small scale. But these efforts have proved abortive, and those concerned in the attempts soon sold out their interests to the pioneer firms or have abandoned the business under even less advantageous circumstances. For this reason the entire oyster fishery of San Francisco Bay is now controlled by the two firms mentioned above.

Methods of planting, etc.—Two kinds of oysters are used for planting; these differ only in age and size and are called respectively "seeds" and "plants." Both kinds are brought from the Atlantic coast. No success has yet been met in breeding oysters in San Francisco Bay, and it is the belief of those familiar with the local conditions that the temperature of the water is unfavorable on account of the cold streams emptying into the bay.* For this reason the young oysters have to be

* There is considerable difference of opinion, according to Wilcox, concerning the question of the propagation of oysters in San Francisco Bay. While some hold stoutly to the theory that there is no "set" of spat, or, if so, contend that it dies before reaching maturity, others point to the fact that young "seed" brought from the East thrives and grows exceedingly well. They naturally ask why young oysters that have hatched and set here should not do as well as those brought from distant waters. Some who have had long experience in the business concede that there is a limited natural set, and though this is a much-disputed point, the increase in the output of the beds following a reported decrease in importations would seem to give some reason for believing it. On the other hand, if it is a fact that the oyster breeds naturally, why then should it be necessary to replenish the beds with new "seed" and "plants," even so much as now? For surely the oyster has had ample time to become acclimated and to show the results of natural increase in a marked manner if the conditions are at all favorable. It is, therefore, easy to see that the evidence on either side is not yet of a decisive character.

obtained from the East. "Seed" are 1-year old oysters; they are left on the beds 3 years, after which they are taken up as required and the largest are sent to market, while the smaller ones are returned to the beds again. "Plants" are two years old and are left upon the beds 2 years before being culled for market. Thus the marketable age of the oysters in San Francisco Bay is about 4 years. It is generally agreed that oysters grow rapidly in these waters.

"Seed" and "plant" oysters are brought from the Atlantic coast in spring and fall, when the conditions are most favorable. They are transported by the carload on freight trains, and are usually about three weeks on the road.* With favorable weather they survive the journey with only small loss. The smallest oysters or "seed" stand transportation best and comparatively few of them die. From 85 to 95 barrels of these oysters are shipped in each car. No ice is used on them. A barrel will hold from 1,500 to 2,000 "plants," and from 4,000 to 8,000 "seed." The cost per barrel in New York is $3.50. A limited supply of full-grown oysters is brought from the East, but the quantity in 1888 was not nearly so large as formerly.

Freight charges fluctuate, but generally speaking the amount paid for transporting a carload of oysters from the Atlantic coast to San Francisco ranges from $400 to $450, or about $5 per barrel.

After it was demonstrated that young oysters would thrive in San Francisco Bay their importation increased rapidly. The largest amount received in one year during the past decade (1878 to 1888) is reported to have been 120 carloads. The average has been about 100 carloads annually. Lately, however, the receipts from Atlantic coast beds have decreased and in 1888 only 48 carloads of "seed" and 20 carloads of large oysters were imported from the East. This may perhaps be accounted for by the fact that recently quite large quantities of native oysters have been brought from the bays of the State of Washington (where they obtain greater excellence than farther south) and planted in San Francisco Bay.

These "natives" never grow to more than half the size of the Atlantic oyster, and they are often much smaller even than that. They have the strong coppery flavor previously alluded to, which they retain even after being transported. Many of the older citizens, having acquired a taste for the native oysters before any others were obtainable on the west coast, prefer them to those brought from the Atlantic. This preference has created considerable trade in the native variety. According to the best authorities, the oysters brought from Shoalwater Bay, Washington, do not thrive so well as those from the East after being planted in San Francisco Bay; consequently only enough are planted to supply the daily demand. No large quantity can be profitably put on the beds at one time, as they die if they remain long in the bay.

Size and location of oyster beds, etc.—The beds that supply the San Francisco market with oysters are located in San Francisco Bay, and mostly

at or near its southern extremity. At Millbrae, San Mateo County, 17 miles south of San Francisco, two oyster companies own some 400 acres of "tide lands," about half of which is cultivated or used as beds. The oyster firms are credited with owning several thousand acres of "tide lands," but there are only some 300 acres in actual use for planting. According to the land-office register at Sacramento the available "tide lands" have all been bought up, both in San Francisco Bay and elsewhere along the coast. If any remain unsold they are in localities not easily accessible or not well adapted to oyster beds. The State sells the "tide lands" at $1 per acre, regardless of the purpose to which they will be devoted. It is believed that a considerable part of those lands have been bought purely for speculative purposes, and for this reason no record can be obtained of the quantity actually purchased for oyster beds.

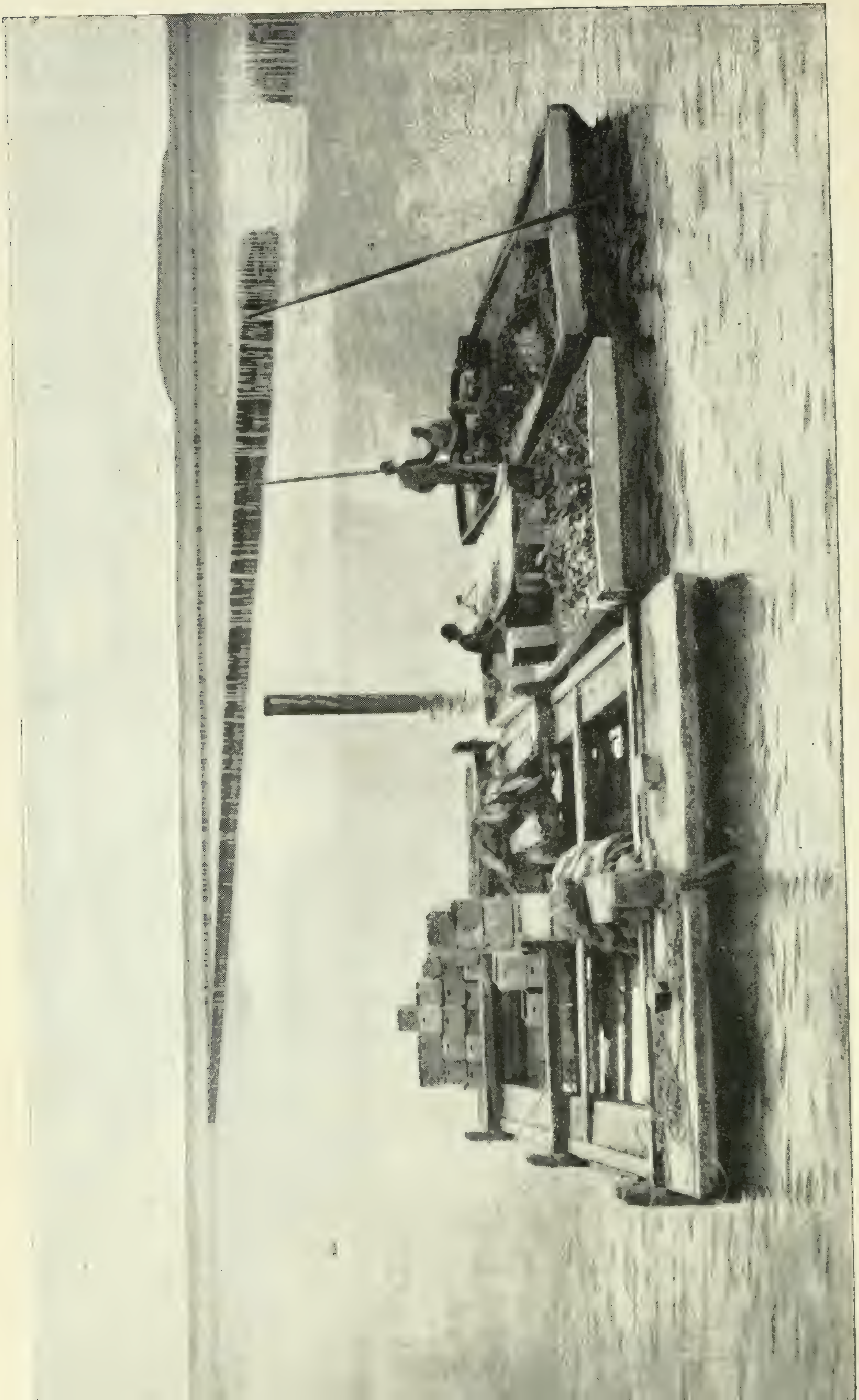
In locating the beds, shell banks are preferred. As a rule these uncover, or nearly so, at low tide. The ground is first made smooth, and then covered with a layer of large oyster shells,* and over these are spread, as evenly and smoothly as practicable, the smaller shells of the native oyster. When the bed is completed the "seed" or "plants" are spread over as thickly as experience has shown to be profitable.

Enemies, protection, etc.—The oysters in San Francisco Bay do not suffer from the depredations of starfish, as they do in certain sections of the Atlantic coast waters. Here the enemy most dreaded by the oyster-planter is the stingray (*Myliobatis californicus*), which is found from Cape Mendocino southward. It is nearly as bad as the starfish on the east coast, and is a serious hindrance to the profitable prosecution of the oyster industry. The powerful jaws of these pests enable them to destroy the oysters whenever they can reach them. It is, however, comparatively easy to guard against their depredations by building fences around the oyster beds. These fences are made of 2 by 3 inch redwood scantling driven about 3 inches apart, and going about 4 feet into the ground. If the beds are much exposed to rough weather or sea, two, and sometimes three, rows of scantling are driven. The cost of fencing is considerable, the price of each piece of scantling being $12\frac{1}{2}$ cents. The stingray appears in April and remains 4 months in the bay. After it leaves, openings are made in the inclosures to permit the tide to carry out the mud washed down on the oyster beds from the neighboring hills.

The oyster beds at Millbrae are located about a mile from the shore, and are owned and worked by the two companies before referred to, each having its own grounds fenced in. At low tide these beds are bare, or nearly so, but they are covered with 8 feet of water at high tide.

Methods of fishing, culling, transporting, etc.—Each of the two firms interested in the oyster business has a station consisting of a house built

* These are collected from the hotels and saloons of the city.



CULLING OYSTERS, SAN FRANCISCO BAY. INCLOSED OYSTER BEDS IN BACKGROUND.

on piles, on or near its oyster beds at Millbrae. The employés live and sleep at these stations, and also keep their boats and scows there. A watch is kept to prevent depredations. One company has bored an artesian well 250 feet deep into the bottom of the bay; this furnishes an abundant supply of fresh water that is pumped into a tank by a windmill, and carried by piping a mile distant to its other station. The oysters are tonged and loaded upon scows. The latter are secured head and stern to stakes driven into the bottom so that the men can operate upon a spot until it is thoroughly worked over, when they move to a new location. In this manner they can go over the beds systematically.

The oysters are culled and packed in boxes, each of which holds 200, or put into sacks holding 36 pounds each. The filled boxes and sacks are loaded on the large cargo scow to await the arrival of the transport.

Six small sloops (the *Boss*, *Challenge*, *Leader*, *Dandy*, *Elsie*, and *Pet*)* are employed in carrying the oysters to San Francisco, where they are distributed to the trade in the shell or opened and put into tin cans that are packed in ice and shipped to towns in the interior or along the coast. A sloop will carry 150 boxes. Two cargoes, or 300 boxes, and 60 sacks, is the daily average taken to the city throughout the year.

The market price of oysters in the shell ranges from \$1.50 to \$2 per hundred. Packed in tin they sell as follows: Cans holding two dozen oysters each, \$4 per dozen cans. Cans holding three dozen each, \$6 per dozen cans. Cans holding four dozen each, \$7 per dozen cans.

Trade.—The annual output of the oyster beds in San Francisco Bay amounts to 117,000 bushels (equal to 109,500 boxes) of large Atlantic oysters, with a value, at first hand, of \$465,375; and 13,000 bushels (equal to 21,900 sacks) of native oysters, worth \$43,800. This makes a total of 130,000 bushels with an aggregate value of \$509,175. A limited quantity of fresh oysters in tins is brought from the East, the cans being packed in ice. The amount so disposed of is not important as compared with the product of the local beds, and exercises only a small influence on the market.

THE CANNING INDUSTRY.

When cognizance is taken of the vast resources which the city possesses in the way of fresh-fish supply; of the large extent of territory which is more or less dependent on it for fresh, preserved, and manufactured fishery products; of the many countries having no important fisheries that are in commercial relations with the western metropolis, it appears somewhat strange that fish-canning, which is of so much

* Three of these are only sailboats, too small to be documented at the custom-house. The *Boss* is 11.40 tons; the *Challenge* 17.31 tons; the *Leader* 10.86 tons; *Pet* and *Dandy* 4 tons each, and *Elsie* about 2 tons. The total value is \$3,800. The first three have crews of two men each; the other boats are managed by one man on each.

consequence elsewhere, has not taken a more prominent place among the industries of San Francisco.

Salmon canning.—In 1888 only two fish-canning establishments were in operation in San Francisco. These were devoted to salmon-canning, but not exclusively, for considerable attention was paid to the preservation of fruit. The salmon utilized were mostly received from Humboldt County, although considerable quantities taken at the mouths of the rivers on the eastern side of San Francisco Bay were also used. The business was prosecuted with the most vigor when there was a surplus of fresh salmon in the San Francisco market and prices were low. In 1888 there were 453,700 pounds of salmon consumed in the preparation of 6,875 cases of canned fish. The fresh fish were valued at $22,685, and the resulting canned goods were worth, at the average price, $41,250, leaving $18,565 as the gross profits of the business. It seems probable that the salmon-canning industry of San Francisco is now almost as extensive as is warranted, taking into consideration the distance of the principal fishing grounds, the city's great demand for fresh salmon, and the enormous pack on other portions of the coast where better facilities exist. So far as other fish are concerned, however, San Francisco is seemingly the most available point in many respects, and there is reason to believe that it might maintain numerous factories for the utilization of the abundant supply of herrings, sardines, anchovies, and many other species found in the waters of the bay and the adjacent ocean.

Sardine canning.—An attempt has recently been made to establish at San Francisco a sardine-canning industry, but the business had not developed to important proportions in 1888–89, though a cannery had been started under competent management and some goods had been packed. As has been stated, the sardine of the Pacific is so much like the European sardine or pilchard (*C. pilchardus*) that it would be difficult for any one but an expert to tell one from the other, except, perhaps, by the difference in size, the western species being much the larger. Indeed, the chief obstacle to the profitable canning of the sardine at San Francisco is its size. It is well known that only the young or half-grown pilchards are used in Europe for the preparation of sardines. Fish of this size have been considered more delicate and better adapted to canning in oil than larger ones, and the trade has come to recognize this to the extent, at least, that it demands sardines of the standard size, or a close approximation thereto. Wilcox thinks that young sardines of suitable size for canning can be obtained for nearly half of the year, as the species migrates from point to point, being south in winter and moving north in spring and summer. This is a matter of great consequence, for the excellent quality of the Pacific sardine will undoubtedly bring it into high favor.

The anchovy, which is much smaller than the sardine and a most excellent food species, is a good substitute for canning purposes, and

doubtless will in time come into marked commercial importance for this purpose.

It is pertinent to remark here that in the county of Cornwall, England, full-grown pilchards are canned in oil, like sardines, and have the trade name of "pilchards in oil." In 1883 I visited a cannery at Mevagissey, in Cornwall, and had opportunity to test the quality of the products. The "pilchards in oil" were excellent and quite as good as the smaller sardines. The demand for them was large and increasing.

In the New England sardine industry herring too large for "oils" are extensively put up in 1-pound cans with mustard, spices, tomato sauce, etc., and meet with ready sale. Fish from 6 to 8 inches long can be thus utilized. Larger individuals can be profitably put in 2-pound and 3-pound square, oval, or round cans. It therefore seems possible that the full-grown sardines of the Pacific might be utilized in this manner, and it is probable that time and a proper effort would overcome any prejudice now existing concerning the size of the fish.

STATISTICS.

The following statistical statements apply to the entire fishing industry of San Francisco and the adjacent regions embraced in this section, and show in detail the persons employed, capital invested, and results of the fisheries:

Nativity and nationality of persons employed in the fisheries of San Francisco Bay and vicinity in 1888.

Country.	Fishermen.		Shoresmen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	620	895	75	75
Mexico	3	3		
Central America	2	2		
South America	18	18		
Austria	2	1		
Belgium	1	1		
Denmark	20	14		
France	12	10		
Germany	55	46		
British Provinces	231	182		
Greece	26	20		
Holland	3	3		
Italy	114	49	25	25
Norway	124	118		
Portugal	145	56	40	40
Russia	74	52	30	30
Spain	46	42		
Sweden	151	139		
China	807	807	80	80
Japan	29	29		
Sandwich Islands	15	13		
South Sea Islands	14	12		
Total	2,512	2,512	250	250

Apparatus and capital.

Designation.	No.	Value.
Vessels (tonnage 11,820.65)	71	$1,032,500
Outfit (not including apparatus of capture)		440,075
Boats	432	96,030
Apparatus of capture as follows:		
Gill nets	1,332	80,720
Trammel nets	315	14,175
Seines, bag nets, etc	1,563	44,275
Pots	1,200	3,300
Hand lines, trawl lines, and minor apparatus		17,955
Shore property		105,000
Cash capital		155,000
Total		1,989,030

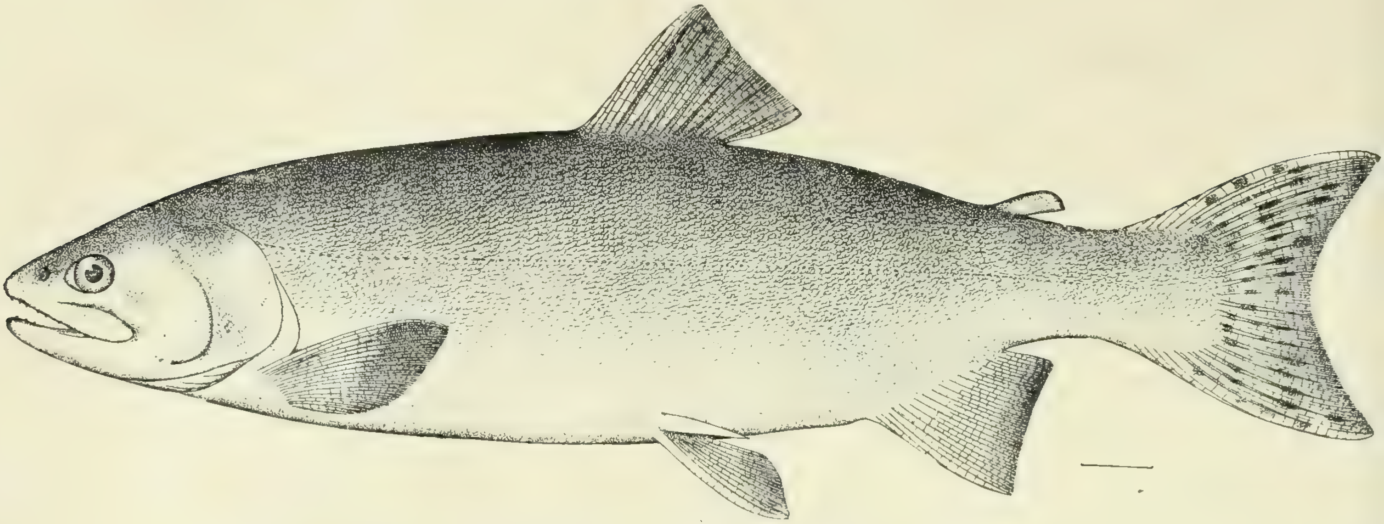
Summary, by fisheries, of the San Francisco vessel fisheries in 1888.

Fishery.	No. of vessels.	Net tonnage.	Value of vessels and outfit.	No. of fishermen	Value of catch.
Whale	28	8,278.46	$1,081,000	932	$682,985
Fur-seal and sea-otter	12	630.52	104,700	213	69,255
Cod	9	1,689.72	125,800	196	89,947
Market	2	41.09	16,500	12	5,200
Fur-seal, salmon, and oyster freighting	20	1,180.86	164,850	98	
Total	71	11,820.65	1,492,850	1,451	847,387

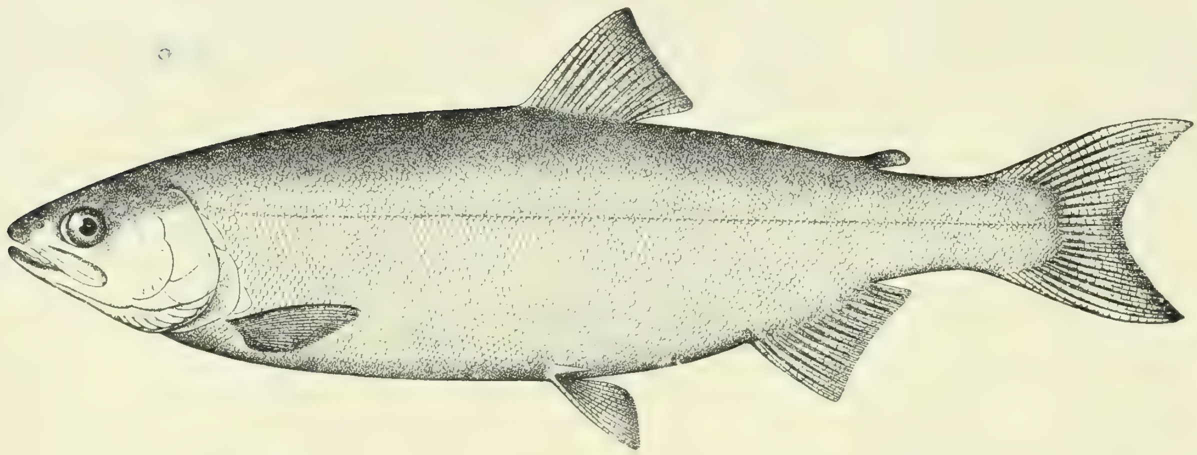
Products and values.

Species.	Quantity.	Value.
Fish:		
Salmon, fresh ... pounds	428,000	$30,200
Shad, fresh ... do	14,000	1,120
Other fresh fish ... do	6,282,554	402,473
Miscellaneous dried fish ... do	4,250,000	101,760
Total	10,974,554	535,553
Mollusks:		
Oysters ... bushels	130,000	509,175
Clams and mussels ... pounds	2,294,415	75,248
Abalone shells and meats ... do	2,600,000	55,000
Octopus and squid ... do	14,000	1,120
Total		640,543
Crustaceans:		
Crayfish ... pounds	25,000	2,000
Crabs ... do	230,000	37,200
Shrimp and prawn ... do	4,902,360	141,688
Total	5,157,360	180,888
Reptiles:		
Terrapins and frogs ... number	51,600	12,900
Mammals:		
Skins of hair seals, sea lions, and walrus ... number	121	4,205
Pelts of fur seal ... do	*104,455	1,576,730
Pelts of sea otter ... do	2,646	215,159
Whalebone and walrus ivory ... pounds	197,060	585,895
Whale and seal oil ... gallons	284,959	102,384
Total		2,484,373
Grand total		3,854,257

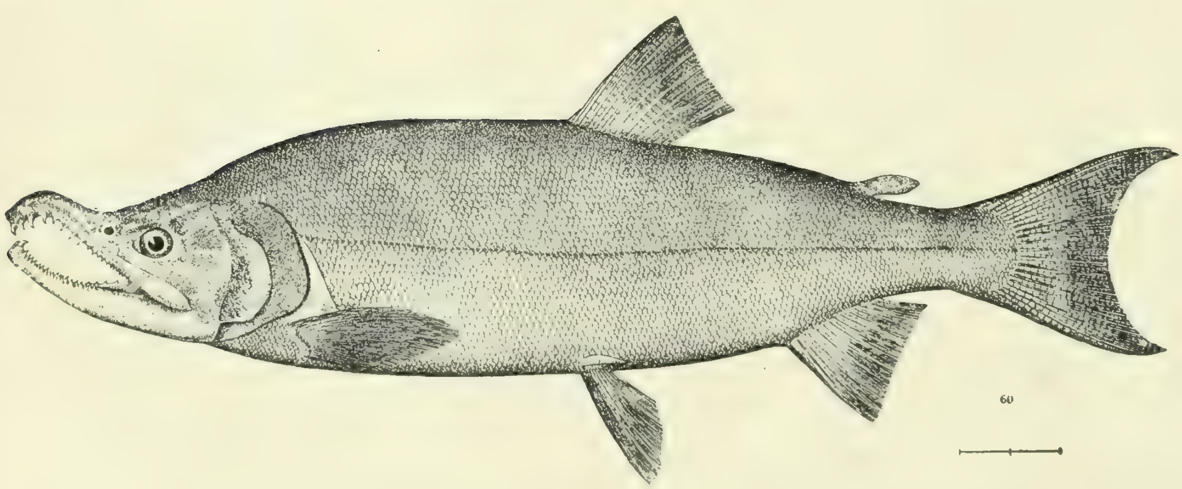
* These figures include the number and value of fur-seal skins taken at the Pribilof Islands, in Bering Sea, which are a product of a fishery carried on by San Francisco capital. In 1888 the full limit of 100,000 skins was obtained at these islands, the value of which, as laid down at London, where they were sold, was estimated to be $1,550,000 In addition to the foregoing, the fur-seal industry of the Commander Islands (which belong to Russia) was controlled by American capital and the product was brought to San Francisco. In 1888 this amounted to 47,362 skins of fur seals, having a value of $544,663 at the average price paid in London. Combining these figures, we have as the total yield of the fur-seal industry in 1888, $2,121,393.



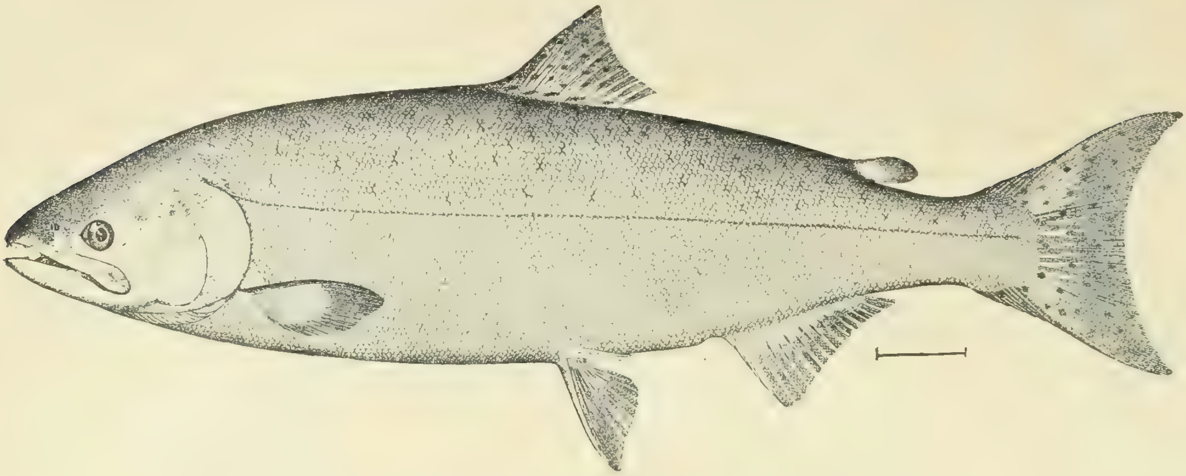
HUMPBACK SALMON (*Oncorhynchus gorbuscha*). Sea-run.



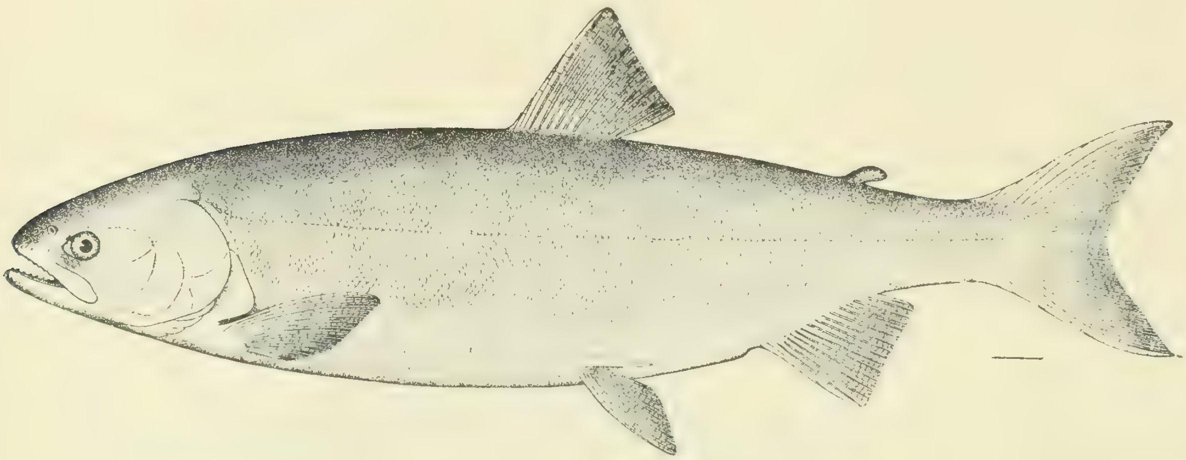
BLUEBACK OR RED SALMON (*Oncorhynchus nerka*). Sea-run.



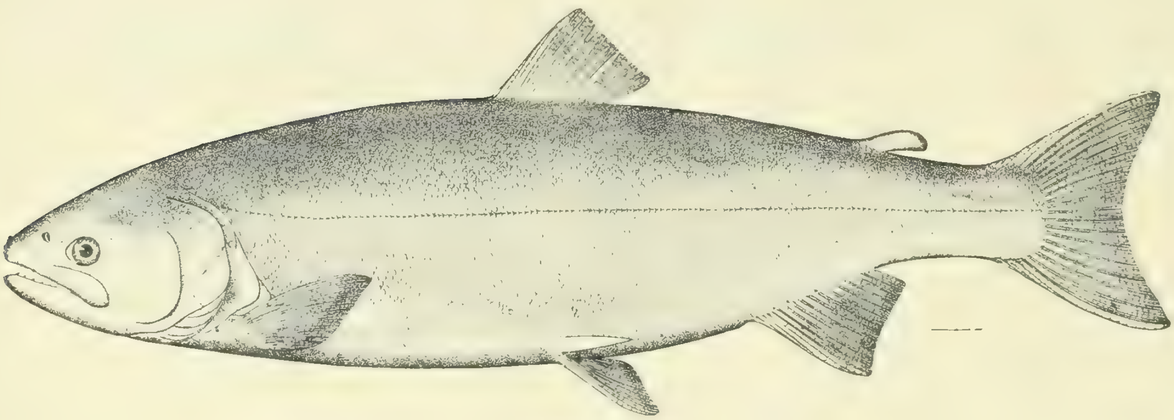
BLUEBACK OR RED SALMON (*Oncorhynchus nerka*). Breeding male.



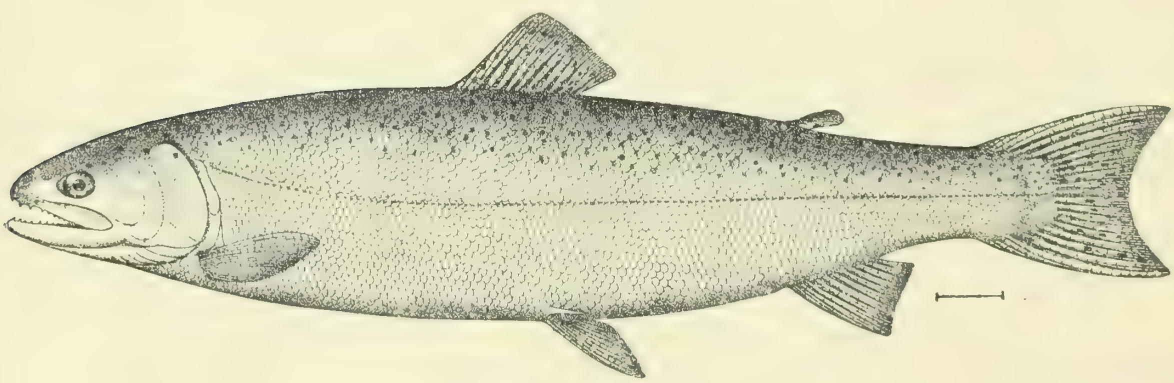
KING, CHINOOK, OR QUINNAT SALMON (*Oncorhynchus chouicha*).



DOG SALMON (*Oncorhynchus keta*).



SILVER SALMON (*Oncorhynchus kisutch*).



STEELHEAD (*Salmo gairdneri*).

21. FISHERIES OF THE SACRAMENTO AND SAN JOAQUIN RIVERS, INCLUDING PARTS OF SUISUN AND SAN PABLO BAYS.

Geographical characteristics, etc.—The Sacramento and San Joaquin are the two most important rivers in California, and the watershed of a large portion of the State is tributary to them. The Sacramento rises in the Trinity Mountains, a spur of the Sierra Nevada range. Its general trend for the first few miles is northerly to the point where it is joined by the Pit River, thence it winds its zigzag course in a west-southwesterly direction until it reaches the valley east of the Shasta range of mountains, when it turns abruptly southward; thence its general course is nearly south-southeast until it empties into Suisun Bay. The lower part of the river, however, below Sacramento, runs southwesterly. Fed by the melting snows on the mountains, its head-waters are specially adapted to the salmonidæ; they constitute favorite breeding-grounds for salmon, and have long been justly celebrated for an abundance of large trout. The lower part of the river is adapted to fishes of other species which do not require such a low temperature as the trout and salmon.

The San Joaquin has its source in the Sierra Nevada Mountains. Flowing westerly through Fresno County for the first 50 miles of its course, it then turns abruptly to the north just where it is joined by Fresno Slough, which drains Lake Tulare.* From this point its general course is northwesterly through the counties of Fresno, Merced, Stanislaus, and San Joaquin, and it passes between the counties of Sacramento and Contra Costa, where it joins the Sacramento River, near the latter's mouth. The Chouchilla and Fresno Rivers, both of which rise in the Sierras, are the principal tributaries of the San Joaquin. The latter is about 350 miles long, and of considerable size, but muddy. The fisheries are unimportant, except near the mouth of the river. In the upper part of the river, catfish, perch, and suckers are reported abundant, while sturgeon, shad, pike, and salmon are the most important varieties in the lower reaches of the stream. Comparatively few salmon enter the San Joaquin, and these rarely go very far up river. It is probable that the muddy condition of the water, and possibly the temperature, prevent salmon from ascending to the headwaters.

Fishing centers.—The principal fishing centers are Sacramento, Sutterville, Clarksburgh, Courtland, Walnut Grove, Rio Vista, Black Diamond, Collinsville, Chipp's Island, Benicia (on Karquines Strait), Martinez, Porte Costa, and Vallejo. A considerable number of salmon fishermen live at Jersey Landing and Antioch, on the San Joaquin, but fish in both rivers and the adjacent bay. The Central Pacific Railroad passes through the towns located on the south side of Suisun Bay and the mouth of the San Joaquin, and a branch of this road runs from Sacramento to Benicia and Vallejo. At several of these places are located

* On some maps Fresno Slough is given as the headwaters of the San Joaquin.

salmon canneries, to which the fisheries are in large measure tributary. Considerable quantities of fish besides salmon are taken to supply the local trade along the rivers, including the places referred to, and to ship to San Francisco and the interior.

Species, seasons, etc.—Salmon of large size and excellent quality are abundant in the Sacramento in their season. The period of greatest general abundance is from April to the last of August. A few are caught all through the other months, except September, which is the close season. The largest catch is in April, May, and August. There is a dull season from the middle of June to the middle of July, during which time the canneries usually suspend operations. The catch during this period is sold fresh for immediate consumption. The quinnat or king salmon is the one chiefly taken; the dog salmon (*O. keta*) and the humpback salmon (*O. gorbuscha*) occur in less numbers, while there is a fall run of silver salmon, according to Jordan.

The weight of the salmon varies from 5 to more than 50 pounds, and the ordinary weight ranges from 14 to 18 pounds. The largest are generally taken in August, but an occasional big salmon is caught in early spring. Formerly the largest fish were always found in the "spring run."

During the last 10 days in August, 1888, the largest catch of the season was made; salmon were reported more abundant than they had been for many years. On some occasions during this period the canneries at Chipp's Island and Black Diamond handled as many as 18,000 salmon (more than 270,000 pounds) in a single day, and this notwithstanding they could not, on account of inadequate facilities for packing, receive many boatloads of fish that were offered. The spring catch of 1889 showed an important improvement over the early fishing of 1888. The fish were larger than usual, being fully equal to the ordinary fall run of salmon, and were more numerous than for several previous years.*

The shad has become one of the commercially important species of the Sacramento River, where, next to San Francisco Bay, the largest yield of this fish is obtained. It is most numerous in the lower river, but many shad are taken as high up as Sacramento. The average weight is 5 pounds. In 1889 the first shad taken in the upper river were caught near Sacramento on April 23; they weighed 4 pounds each.

Trout of large size occur in the upper river. They were formerly very plentiful, but have materially decreased in recent years. This diminution is believed to be due chiefly to the large quantities of sawdust in the river. A law has recently been enacted by the State making it illegal to throw sawdust into the river after September, 1889, and it is hoped that the effect will be beneficial.

Catfish, carp, chub, hard-head, and split-tail are taken in greatest

*It has been noted by Mr. Wilcox that these seasons of abundance had a direct relation to the operations at the hatching station of the U. S. Fish Commission on the McCloud River. Large plants of salmon fry have generally, if not invariably, been followed (3 or 4 years later) by good catches of fish in the Lower Sacramento.

numbers above Sacramento, mostly in fyke nets. The same species occur in the upper part of the San Joaquin, but there is no regular fishery for them there. Perch, pike, and sturgeon are found in both rivers; the latter average 35 pounds in weight. Striped bass are occasionally caught. One taken about April 17, 1889, near Benicia, weighed 24 pounds; it sold at retail for $1 per pound.

Terrapin occur in the marshes near the mouths of these rivers, and are taken in limited numbers for the San Francisco market.

Fishing grounds.—The fishing grounds for salmon are generally Suisun Bay, the lower part of San Joaquin River, and the Sacramento River as high as the vicinity of Sacramento City. Next to the Columbia River, the Sacramento is the most important salmon stream of the Pacific coast States. The fishermen of each district generally go no farther than 5 miles above or below the cannery or steamboat landing where the catch is landed. Salmon do not run into the San Joaquin in large numbers. In the fall, when the fishery is at its best, fishermen go a few miles up the Mokolumne, a small stream that empties into the San Joaquin, about 20 miles or so above Black Diamond. Three-Mile Slough, some 5 miles nearer the town mentioned, is also fished to some extent.

Fishermen and shoresmen.—The fishermen on the rivers are almost wholly of European birth, though about 30 per cent. of them have become naturalized citizens of the United States. Of the 1,102 fishermen working in the region under discussion, only 60 were born in this country, 477 were natives of Italy, 425 came from Portugal, 150 from Sweden, and 90 from Germany. The Swedes have shown the greatest desire to become citizens, 70 per cent. of them having been naturalized.

Many of the fishermen are unmarried, and these find it most satisfactory to live upon scows, which, as the salmon migrate and the centers of abundance change, are towed from one part of the river or bay to another to suit the convenience of the occupants. Some of the married men have large scows, upon which are 2 or 3 rooms, and these generally take their families along with them and follow the fleet of boats and scows up and down the river. Generally, however, those who have families live on shore with them. During the close season for salmon, or when the catch is light and the canneries closed, the scow towns break up, and many of the fishermen go to the places they consider home. But when the season begins and the canneries are running they take to the bay and rivers, where their unique habitations may be found along the shores near the best fishing grounds.

Of the 295 men in the canneries 40 are natives of this country, and the remainder are Chinese. The Americans are the bosses, clerks, etc., while the Chinese constitute the "help."

Regarding the employés in the canneries, it is proper to state that it is somewhat difficult to arrive at the figures with exactness. Some of the packing establishments also do an extensive business in canning

fruit, and there is necessarily a commingling of interests. The number of persons employed, even at the canneries that handle salmon exclusively, fluctuates considerably. In periods of abundance all available "help" is procured, but any decrease in the supply of fish is immediately followed by a corresponding diminution in the force. The figures already given represent the average number of employés which can properly be included under the head of salmon canning.

Vessels and boats.—During the salmon season there were 12 small vessels employed on these rivers and adjacent waters in the capacity of tenders or freighters for the canneries. They visit the principal fishing grounds and collect the catch of the boats, which they transport to the respective canneries they are working for. With one exception these are all sloops; two of them—the *Boss* and *Challenge*—are employed part of the year as transports in the San Francisco oyster trade, and have been mentioned in that connection. The size ranges from 5 to 17 tons; the average is about 12 tons.

These vessels are owned at San Francisco, Vallejo, Benicia, and Black Diamond, but all are documented from the San Francisco custom-house and hail from that port; they have therefore been included with the statistics of that city, though, for the sake of clearness, they are mentioned here. These vessels are in no sense typical fishing craft. Many of them are old; they are of varying models, and there seems to be no effort made to keep them in shipshape order. So long as they hold together and can carry a cargo of fish in smooth water, nothing else appears to be required. The value ranges from $250 to $500 each. Two men constitute a crew. Their names, rig, and net tonnage are shown in the following list:

Name.	Rig.	Net tonnage.	Name.	Rig.	Net tonnage.
Boss	Sloop	11.41	Josephine	Schooner.	16.41
Challenge	...do	17.31	Knickerbocker	Sloop	5.01
Colonel	...do	9.01	Liberty	...do	12.74
Fannie Samos	...do	10.46	Lizzie M	...do	15.14
Ida	...do	14.74	May Fowler	...do	13.85
J. A. McClellan	...do	9.46	Twilight	...do	10.16

The typical salmon gill-net boat is used here for fishing, but it is not so large, on an average, as the boats on the Columbia River, and has less stability and seaworthiness.

The scows on which many of the fishermen live are much like the "arks" used by the gill-net shad fishermen on the Potomac River. "They are variable in shape and appearance; flat-bottomed, with vertical parallel sides narrowed and slanting somewhat toward each end. They are boarded over above and are nearly covered by the house, only a narrow margin being left around the sides. The house generally has but one room with a door at one end and two windows on each side. It is flat-roofed. Probably an average-size scow would be 20 feet long and 12 feet wide, the house about 7 feet high and occupying

all of the scow but a strip about 18 inches wide on each side and 2 feet wide at each end."* The average value of a scow is estimated at $250.

Apparatus and methods of capture.—Gill nets are exclusively used in the salmon fishery. Wilcox states that the salmon nets now in use on the lower Sacramento range in length from 150 to 300 fathoms and in depth from 4 to 5 fathoms, or 40 to 45 meshes of 8 to 8¾ inches each. He places the value at from $200 to $400. There seems to have been a decided change in the depth of this apparatus in the past 10 years. Jordan and Gilbert found the nets used in 1879 to be "from 200 to 300 fathoms long, from 6 to 9 fathoms deep, and with an average mesh of 8¾ inches." They place the value at $300. Nets of this size are operated only in the bays and lower sections of the rivers, where most of the catch is obtained. In the vicinity of Sacramento City, the upper limits of the fishery, nets are much smaller, ranging from 75 to 100 fathoms in length, and usually having only a 7½-inch mesh. From Rio Vista to Carlinville the nets are from 150 to 250 fathoms in length; and between the latter place and Benicia they vary from 200 to 300 fathoms. The nets are all handmade by the fishermen during the dull season; they usually last about 2 years. Some of the men, however, prefer to engage in some other pursuit at that time and pay the net-makers for knitting and hanging their gear.

Jordan and Gilbert, in the same article, make the following reference to the method of fishing:

Fishing is always done on the ebb tide, whether it be day or night. Two men always work together. They go out to their fishing grounds, which are chosen chiefly by clear channel, and the net is placed in the water, one man working the boat and the other paying out the net. Everything is governed by laws which the fishermen have made for themselves. Each of the two men has his own part in the work. It is always the same one who rows, while the other manages the net. The two then rest in their boat, boat and net floating down together until they have gone far enough, when the net is taken out and the fish removed. The distance they float, of course, varies with the grounds and the seasons.

According to a law among fishermen, a second net is not to be placed in the water until the first one has floated down a certain distance, and although the fish are all caught running up the stream the second, third, and even fourth net frequently catches more than the first. They generally begin fishing at about half ebb tide.

In spring, when the water is muddy, the day fishing is generally as good as at night. Later in the season, when the river is comparatively clear, the best results are obtained at night, particularly when there is no moon. A State law prohibits net fishing between sunrise on Saturday and sunset on Sunday, in addition to total cessation during September. The laws are said to be often violated, notwithstanding the patrol of the river by the State fish commissioners.

Shad are taken incidentally in the salmon nets.

*The Salmon Fishing and Canning Interests of the Pacific Coast, by David Starr Jordan and Charles H. Gilbert, volume I, section V, of Report upon the Fisheries and Fishery Industries of the United States, p. 732.

Hoop nets are used to some extent by the Chinese employés at the canneries for the capture of catfish, which gather around the wharves and buildings, attracted by the refuse thrown into the water. Fyke nets are used about Sacramento for the capture of several varieties of coarse fish. "They include chubs, herring, perch, viviparous perch, sturgeons, hard-heads, split-tails, Sacramento pike, suckers, crabs." The fyke nets usually have a 2½-inch mesh and wings about 14 feet long. Each net has 4 hoops. They are set close inshore, and the best results are obtained when the river rises and the fish run in near the banks. Fishing with fyke nets is carried on from November to May. It is discontinued in summer because the water is warmer and the fish poor. The nets are generally lifted each morning, and the fish are shipped to San Francisco the same day, at least such as are not sold locally.

The extent of the salmon fishery, past and present.—In the early days of the salmon fishery on the Sacramento old inhabitants state that as many as 1,000 boats were used on the river between Sacramento and San Francisco Bay. Both boats and nets were then much smaller than they are at present. In 1888, 504 boats were employed on the two rivers in addition to about 150 others engaged in the fishery from San Francisco and vicinity, which have been included with the statistics of San Francisco Bay.

After October not more than 75 boats are usually engaged in salmon fishing, and practically the entire catch is sold fresh, for immediate consumption, either in the towns or peddled through the country. None of the product at that season is used for canning. The following table shows the quantities of salmon taken at the various points for the canneries and for sale in the markets:

*The salmon catch of the Sacramento.**

District.	Sold to canneries.	Sold to markets for food.	Total catch.
	Pounds.	*Pounds.*	*Pounds.*
Sacramento	47,520	45,689	93,209
Rio Vista	31,680	30,400	62,080
Black Diamond	2,772,000	1,439,100	4,211,100
Benicia	1,188,000	465,300	1,653,300
Total	†4,039,200	1,980,489	6,019,689

*The figures given in this table include salmon caught on the San Joaquin and packed in the canneries or otherwise disposed of.

†The canneries at these points packed 61,200 cases; 66 pounds of undressed fish being, on an average, required to fill a case.

Salmon-canning.—There is a cannery at Benicia, one at Black Diamond, and a branch cannery at Chipp's Island; these take most of the salmon caught in the lower Sacramento and San Joaquin Rivers, and also those obtained for canning purposes in Suisun Bay. A cannery at Sacramento is supplied with fish caught higher up the river.

The canning of salmon on the west coast of the United States had its origin on the Sacramento River in 1864. Since that time the growth of

the industry on the Pacific coast has been one of the most remarkable features in the history of the fisheries of this country.

Messrs. A. S. Hapgood, William Hume, and George W. Hume, under the firm name of Hapgood, Hume & Co., built the first cannery on the coast. This event was fraught with such important consequences to the Pacific coast that it seems worthy to be recorded in detail. The gentlemen who had inaugurated this enterprise had resided in Augusta, Maine, in their boyhood days. William Hume went to Sacramento in 1850 and his brother George followed in 1855. In 1863 the latter returned home, where he met his former schoolmate, Hapgood, who in the mean time had learned the tinner's trade and had also been engaged in canning lobsters on the Bay of Chaleur, New Brunswick. Hume had observed the abundance of salmon in the Sacramento. He had also lived on the Kennebec, and knew the commercial value of this "king of fishes." Having a mind that was quick to grasp possibilities, the thought naturally occurred to him: If lobsters can be canned for food, why can not salmon be treated in the same way, and the wealth of the Western rivers thus be given to the world? A few conversations with his friend led to preliminary arrangements for the establishment of the firm above named, and the inauguration of a business that has reached proportions not anticipated in the wildest dreams of its originators.

After Hume's return to California his action was ratified by his brother, and, on March 24, 1864, Hapgood reached Sacramento. Ten days earlier, Mr. Robert D. Hume arrived in California and immediately became connected with his brothers as an employé in the firm. Preparations for canning salmon were immediately begun. The cannery was on a floating scow, located in the town of Washington, on the opposite bank of the river from Sacramento. Many difficulties, due to inexperience and crude devices, were met with, and some losses were unavoidable. Nearly 4,000 cases (4 dozen 1-pound cans in each) were packed the first season, but only 2,000 cases were merchantable; the remainder of the pack was worthless and was thrown away.

The machinery and apparatus were very rude, compared with modern devices. The fish was first put into the cans and then boiled in large, round-bottomed iron kettles. Fresh water was used to boil the fish in. The cans, with their vent-holes left open, were placed in the kettles so that the water would not come within an inch of their tops. The boiling continued an hour, after which the cans were taken from the kettles and the vents closed. No test for leaks was made. Next the cans were thrown loose into a bath kettle made of boiler iron. In this salt water was used so that a higher temperature could be obtained; the heat was generally from 228° to 230° F. This frequently burned out the kettle, and many imperfectly made cans were burst and their contents lost. Steam was not used at that time in cooking or otherwise preparing the products. After an hour's bath, the cans were

scooped out of the bath kettle and placed in a tank filled with cold water; they were then wiped off with old rags, and often were left in a rather untidy and unattractive condition, so far as outward appearance was concerned. The ends of the cans were covered with red lead, and in some cases the entire cans were painted. They were then labeled and packed in cases.

The difficulties of the enterprise were not confined to packing, for when the goods were offered for sale in the San Francisco market no one could at first be induced to purchase or even to handle material so entirely unknown to the commercial world. Finally, one commission firm was found that advanced the shipping charges on a part of the pack, which was sent to Australia. The venture was a success; the salmon sold readily and netted $16 per case. As soon as this result was learned the rest of the pack was shipped to the same market, where it met with an equally good reception.

And thus was the salmon-canning industry of the west coast established, and from this small beginning has grown one of the great fisheries of the world, the products of which have become familiar wherever civilization exists.

During the season of 1864, 1865, and 1866, particularly in the latter year, the run of salmon was unusually light on the Sacramento. Packing continued and a good trade was built up with Australia and South America. No sales of canned salmon were made in the United States at that time, since the lack of proper facilities for transportation and ignorance of the value of such products hindered their distribution in this country; but the demand grew rapidly and the scarcity of fish on the Sacramento made it necessary to look for new sources of supply. In the spring of 1866 the Columbia River was visited and the conditions were so favorable that the firm built a cannery at Eagle Cliff, 40 miles above Astoria—the first cannery on the river—and thus became the pioneers of the salmon fishery in that region.

In recent years the supply of salmon on the Sacramento has been diminishing, and, as a consequence, many canneries have devoted considerable time and effort to the packing of fruit, including berries, while other packing establishments have been moved to Alaska.

According to statements of packers, the best season in recent times for salmon was in 1881, when this species was very abundant in the region under discussion. In 1882 and 1883 good catches were made, but the yield was considerably less than in 1881. The years 1884 to 1886, inclusive, showed a large decrease in the supply, and in 1887 the season was the poorest ever known. There was, however, a most gratifying increase in 1888, although the catch did not reach the proportions that it had attained in some of the earlier years.

During the season of 1888 four canneries were operated on the Sacramento River. These were located, respectively, at Sacramento, Black Diamond, Chipp's Island, and Benicia. They employed 295 per-

sons, mostly Chinese, and utilized 4,039,200 pounds of salmon, for which the fishermen received $201,960. The output of the canneries that year was 61,200 cases, for which $390,150 were received. Four other canneries on the river were not in operation in 1888. Only three were open in 1889, and 57,300 cases of salmon were packed.

The lay.—The boats and nets are generally the property of the fishermen, who fish on shares. In case the fishermen do not own the apparatus, the stock of each crew is divided into three parts, one going to the owner of the net and one to each of the fishermen.

Disposition of products.—Previous to 1888 the salmon were sold to the canneries by the piece at prices ranging from 50 to 70 cents each for all fish weighing 10 pounds or over; under that limit two fish were required to represent the value of a single fish over 10 pounds. In 1888 the packers, finding that all large salmon were being sent to market and all the smaller fish sold to them, changed the system and decided to buy the fish by the pound, regardless of size, the prices paid in that year being 4½ to 6 cents, round. Large quantities of various species of fish are shipped in ice to San Francisco and other markets for immediate consumption.

Sacramento as a fish market and distributing center.—Although a certain amount of fresh-water fish is shipped from Sacramento to San Francisco, the receipts of salt-water fish from the latter place are much greater. The following table shows the receipts of market fish at Sacramento in 1888:

Species.	No. of fish.	Pounds.	Value to fishermen.
Salmon	10,292	155,289	$9,317
Shad	261	1,471	74
Sturgeon	147	5,193	260
Pike	36	378	19
Carp		35,475	532
Catfish		125,640	1,885
Hard-head		30,450	609
Split-tail		32,148	643
Chub		1,230	62
Total	10,736	387,274	13,401

The following were the ruling prices received by the fishermen of this region in 1888:

Prices of different species of fish, 1888.

Species.	Price per pound.	Species.	Price per pound.
	Cents.		*Cents.*
Salmon, upper river	4½	Sturgeon	5
Salmon, lower river	6	Hard-head	2
Shad	5	Split-tail	2
Carp	1½	Chub	5
Catfish	1½	Perch	8
Pike	5		

The extent of the fisheries on the Sacramento and San Joaquin Rivers in 1888 is shown in the following tables:

Persons employed.

Country.	Nationality.		Nativity.	
	Fishermen.	Factorymen.	Fishermen.	Factorymen.
United States	402	40	60	40
Italy	352		477	
Portugal	280		425	
Sweden	105		150	
Germany	63		90	
China		255		255
Total	1,202	295	1,202	295

*Apparatus and capital.**

Designation.	Number.	Value.
Boats	520	$100,800
Gill nets	†504	151,200
Fyke nets	30	700
Building, wharves, machinery, land, etc		200,000
Cash capital		100,000
Total investment		552,700

*The small vessels engaged in transporting salmon to canneries on the Sacramento and San Joaquin Rivers have been included in the statistics of San Francisco, where they are owned and documented.

†756,000 feet in length.

Products and values.

Species.	Pounds.	Value.
Salmon, fresh	2,135,778	$106,788
Salmon, pickled	120,000	6,000
Salmon, canned	4,039,200	201,960
Catfish	183,640	2,755
Carp	95,475	1,910
Perch	5,000	350
Pike	3,378	203
Sturgeon	240,193	14,411
Shad	56,471	3,953
Hard-head	30,450	609
Split-tail	32,148	643
Chub	1,230	62
Total	6,942,963	339,644

Additional products, 8,400 terrapin, $2,160.

22. FISHERIES OF MENDOCINO COUNTY.

The shores of Mendocino County are bold and rocky and not adapted to fishing, nor has the county any rivers of note. So far as could be learned, there is no commercial fishing, and at the best it is believed there has been no advance since 1880, when Jordan estimated that the total annual catch could not exceed 3,000 pounds.

23. FISHERIES OF HUMBOLDT COUNTY.

Geographical characteristics.—The land is bold and high along the coast of Humboldt County on the south and north, but in the center of the county, in the vicinity of Humboldt Bay, the shores are rather flat and less striking. The coast is generally unsuitable to sea fishing; there are no inlets or harbors of importance, except at Eureka, on Humboldt Bay, and as this is barred and the sea is usually breaking heavily on the bar, it is comparatively seldom that boat fishermen could be assured of returning safely to the harbor, even if they succeeded in getting to sea. Access to the bay is rendered dangerous for vessels by the narrow, shallow, and shifting character of the channel at the entrance. Humboldt Bay is 12 miles long and about one-quarter as wide. The Mad River enters it on the north and the Eel River empties into the southern extremity of the bay.

Character of the fisheries.—The fisheries of this county are confined to Humboldt Bay and the two rivers mentioned. The only fishery that is prosecuted on an extensive commercial scale is that which has the salmon for its object. There are, of course, besides the salmon, many other varieties of fish, some of which are taken incidentally.

Species, etc.—Several varieties of salmon are recognized by the fishermen, which they know as the silver, hook-bill, dog, steelhead, and humpback salmon. The latter are small, not exceeding 10 pounds in weight on the average, but the general average of salmon is said to be 25 pounds. There is no spring run of salmon in the Eel River. Unlike many salmon streams, it is not fed in the spring by melting snows, but is dependent upon local rains for a full supply of water; consequently it is frequently quite low during the time when salmon are ascending the coast rivers and it is believed that this is the reason why salmon do not enter it in the spring. During the fall and winter, however, fish are abundant; they enter the stream about the first of October and remain until March. In the latter part of the winter the catch is made up largely of steelheads, which are almost entirely absent in the early fall run.

Shad have occasionally been taken in recent years and are increasing in abundance. There is no regular fishery for them, and consequently their actual relative abundance is not known. Those taken are caught incidentally—chiefly in salmon gill nets—the mesh of which is too large to take shad of an ordinary size. In 1888 as many as twelve shad were taken at one haul in a salmon drift-net, which had a 7½-inch mesh, this being the minimum size permitted by State laws. A few shad are annually taken in Humboldt Bay. They first appeared in 1882. About one hundred were reported caught in 1888. Brook trout are numerous in parts of Eel River. Below the forks perch and suckers occur; within a few miles of the mouth flounders are found; and during the summer months herring, smelt, and sardines are plentiful in the bay.

Clams are abundant on the flats about Humboldt Bay; there are several varieties, locally known as soft-shell, small round hard-shell, quohaug, and razor clams. There is no organized fishery for them. The Indians dig a few for local consumption and sell about fifty buckets per week at the two fish markets on the bay, the average price received being 50 cents a bucket.

Fishermen, lay, etc.—A few of the men employed in the fisheries of the Eel River reside in the valley of that stream, but the majority are non-residents of the county who visit the region annually for the purpose of engaging in the salmon fishery, some being from the Columbia River. At Eureka the men are devoted to other business during a greater part of the year. Some fishermen work on shares and others are hired by the month. There is a large foreign element among the fishermen, the countries of Portugal, Italy, Sweden, and Russia all being well represented. The only Chinese in the county are those employed in the canning house, which, however, was not in operation during 1888. These Chinese are hired at San Francisco by the owners of the factory and imported for the season, but leave immediately after the cannery closes.

Boats.—The boats used in this locality are small and inexpensive. The average dimensions are 16 feet in length and 4 feet beam; they have a square stern and flat bottom. Those employed in the gill-net fishery carry one net and two men each. The average value is $20.

Fishing grounds, apparatus, methods, etc.—In October and November, when the bulk of the catch is made, drift nets and seines are operated in the lower 6 miles of the river's course; after the middle of November high water is liable to occur and the fishermen then work the stream as high up as the forks, some 40 miles from its mouth. No regular salmon fishing is done above the forks, although the people living along the banks of the stream catch salmon for their own consumption. The winter yield is light and is chiefly taken with seines in the upper part of the river.

The gill nets operated on the Eel River are 60 fathoms long and 3 fathoms deep; the nets used in the early part of the season have a 9-inch mesh, but later, when salmon are sought in the upper river, nets with a 7½-inch mesh are preferred. The nets are mostly made by the fishermen themselves, and have a value of $50 each. The salmon nets used on the Mad River are from 100 to 150 fathoms long, 14 and 15 feet deep, with a 7½-inch mesh; they are worth from $100 to $150 each. The Eureka fishermen use gill nets about 40 fathoms long, 14 feet deep, with a 2-inch mesh, for catching perch and flounders.

The haul seines operated on the Eel River are factory-made, 150 to 200 fathoms long, 4 fathoms deep in the bunt, and 3 fathoms in the wings; the average value is $300 each; there are 15 in use, and 8 or 9 men are required to operate each of them. There are, in addition, 4 seines fished from Eureka, usually for smelt, herring, and sardines;

these are smaller than salmon seines, and are worth $100 each. Hand-lines are occasionally used in this region, but the catch is small.

Disposition of products.—Owing to the very large run of salmon in the fall of 1888, and the absence of the usual demand from the cannery, there was a large surplus of fish pickled and packed in barrels, this being the only available means of saving them. There was but little time to handle the large catch, and the haste with which the salmon were cured resulted in the preparation of a somewhat inferior article, for which little demand could be found in the market, and in consequence the packers did not receive the remuneration which might have been expected from a season of abundance.

A salmon cannery was established at Eel River in 1877, but this was not in operation in 1888. The employés of the cannery when in operation were Chinese. There are fish enough in the river to maintain a cannery in active operation during the season. The fishermen have considerable difficulty in disposing of all their catch if, for any reason, the cannery fails to open.

Markets and shipments.—About three-quarters of the fresh fish taken in Humboldt County are sent to San Francisco by steamer from Eureka and Field's Landing. The pickled fish, in barrels, also find a market in that city. The monthly shipments of fresh salmon and flounders and the prices generally received are shown in the following table:

Shipments.			Prices.	
Months.	Salmon.	Flounders.	Kinds.	Per pound.
	Lbs.	*Lbs.*		*Cents.*
January	120,900	4,000	Fresh salmon, locally	5
February	34,600		Fresh salmon, shipped	2
March	3,700		Fresh flounders, shipped	3
October	80,900	4,000	Other fresh fish, locally	5
November	252,100	10,000	Clams, locally	1½
December	140,000	2,000	Pickled salmon, shipped ($6 per bbl.)	3
Total	632,200	20,000		

The condensed statistics of the fisheries of this country in 1888 are as follows:

Persons employed.

Country.	Nativity.	Nationality.
United States	76	195
United States (Indians)	26	26
Portugal	108	62
Italy	95	59
Sweden	52	25
Russia	31	21
Total	388	388

Apparatus and capital.

Designation.	No.	Value.
Boats	93	$1,860
Haul seines	18	4,800
Gill nets for salmon	117	7,100
Gill nets for perch and flounders	10	250
Shore property		1,500
Cash capital		2,500
Total		18,010

Products and values.

Species.	Pounds.	Value.
Salmon, fresh	747,200	$18,394
Salmon, pickled	315,000	9,450
Flounders, fresh	20,000	600
Shad, fresh	400	40
Other fish, fresh	41,500	2,075
Clams	72,000	1,200
Total	1,196,100	31,759

24. FISHERIES OF DEL NORTE COUNTY.

Geographical characteristics.—This is the northernmost shore county of the State. It has a short coast line, which, north of the center, is interrupted by Pelican Bay. There are two rivers in which all the fishing of the county is done: Smith River, which enters the Pacific Ocean just north of Pelican Bay, and the Klamath River, which forms the boundary between this and Humboldt County on the south. Smith River rises in the northeastern part of Del Norte County and flows thence in a westerly direction to the Pacific Ocean. The Klamath River issues from the lower Klamath Lake, in Klamath County, Oregon, and runs southwesterly across Siskiyou County, passes through the southeastern section of Del Norte County, keeping its southerly course into Humboldt County, where it forms a juncture with the Trinity River, whence its course is directed to the northwest until it reaches the Pacific Ocean. Near the mouth of the Klamath River is an Indian reservation. The Indians are extensively engaged in fishing for the salmon cannery at the Indian town of Requa.

Importance of fisheries.—The fisheries of Del Norte County supply salmon for the canneries on the Klamath and Smith Rivers. In 1888 there were but two canneries. The one at Requa, on the Klamath, was built in 1888; the one on Smith River was established a number of years previous. The pack in 1888 was light, aggregating only 6,747 cases, valued at $13,012, this representing 440,755 pounds of fish as taken from the water, or 324,856 pounds as canned.

Species, seasons, etc.—Salmon is the only object of the fisheries in Del Norte County. There is only a spring run of this species in Smith River. The Klamath River is important as a salmon stream because

it is one of the four rivers on the Pacific coast which has both a spring and fall run, and also on account of the quality and abundance of the species. Salmon make their appearance as early as April, but the run does not become general until May; it lasts until about October; the fall migration begins about September 15 and lasts until November 15. Fishing is carried on only near the mouth of the river because of the falls about 3 miles above.

Apparatus, boats, etc.—Gill nets are generally used to capture salmon. In 1888 there were 60 nets in use, the average length being 300 feet, the nets having a value of from $60 to $80 each. Two seines were used on the Smith River. The boats used on the Smith and Klamath Rivers are small skiffs and Indian canoes.

Disposition of products.—The fish taken on Smith River were utilized at the cannery near the mouth of that stream. The salmon caught on the Klamath River were sold for canning purposes at 5 cents per pound; 70,000 pounds more were shipped to Rogue River, Oregon, and there packed. The Indians on the Klamath also captured large quantities of fish, chiefly for home consumption, a considerable quantity being cured for winter use.

The following tables show the principal phases of the fisheries:

Persons employed.

Country.	Fishermen.		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	15	19	11	11
United States (Indians)	42	42	35	35
Sweden	6	2		
France	4	4		
Great Britain	3	3		
China			2	2
Total	70	70	48	48

Apparatus and capital.

Designation.	No.	Value.
Boats	84	$2,150
Seines	2	300
Gill nets	60	5,000
Factory and accessories		13,600
Cash capital		10,000
Total		31,050

Products and value.

Species.	Pounds.	Value.
Salmon, fresh	*653,857	$33,993
Salmon, salted	80,000	3,200
Total	733,857	37,193

*This includes 70,000 pounds sold by fishermen of Requa to cannery on Rogue River, Oregon.

III.—THE FISHERIES OF OREGON.

25. GENERAL REMARKS.

Oregon ranks next to California in the extent and value of its fisheries. The State has no vessels employed in fishing,* but its shore salmon fishery is of vast extent, that in the Columbia River surpassing in magnitude any other stream on the globe. In the importance of its salmon-canning interests Oregon takes first place, the output of canned goods in 1888 amounting to nearly $2,000,000. The extent of the salmon-canning industry in 1888 is shown in detail in the accompanying statement:

The salmon-canning industry of Oregon in 1888.

Location of canneries.	No. of canneries.	No. of factory hands.	Salmon used for canning.		Canned salmon placed on market.	
			Pounds.	Price paid fishermen.	Cases.	Value.
Rogue River	1	106	1,474,340	$29,487	21,062	$121,107
Coquille River	2	40	770,000	11,550	11,000	63,250
Koos Bay and River	1	46	385,000	5,775	5,500	31,625
Umpquah River	1	51	675,000	13,500	9,000	51,750
Siuslaw River	1	45	837,200	12,558	11,960	68,770
Alseya River	3	65	673,400	10,101	9,620	55,315
Yaquina River	3	61	352,344	10,570	5,088	29,256
Nestuggah River	1	38	350,000	5,250	5,000	28,750
Tillamook River	2	87	1,074,310	21,236	14,633	84,140
Neconicum Creek	1	8	28,000	420	400	2,300
Columbia River	18	1,037	14,771,054	769,325	227,559	1,365,354
Total	34	1,584	21,390,648	889,772	320,822	1,901,617

The following tables give the figures of persons employed, apparatus, and products for each stream that maintains commercial fisheries:

Persons employed in the fisheries of Oregon in 1888.

Streams.	Fishermen on vessels.	Fishermen on boats.	Shoresmen.	Total.
Windchuck River		2		2
Chetco River		30		30
Rogue River	18	41	106	165
Elk River		5		5
Sikhs River		7		7
Coquille River		184	40	224
Koos Bay and River	4	58	46	108
Umpquah River		38	51	89
Siuslaw River		136	45	181
Alseya River		92	65	157
Yaquina River		78	61	139
Nestuggah River		30	38	68
Tillamook River		154	87	241
Neconicum Creek		6	8	14
Columbia River	31	2,104	1,037	3,172
Willamette River		80		80
Total	53	3,045	1,584	4,682

* No vessels were actually engaged in catching fish in 1888, but a few small steamers and sailing vessels were employed in connection with the canneries.

Nativity and nationality of persons employed in the fisheries of Oregon in 1888.

Country.	Vessels.		Boats.		Shore.		Total.	
	Nativity.	Nationality.	Nativity.	Nationality.	Nativity.	Nationality.	Nativity.	Nationality.
United States	32	44	693	2,075	174	221	899	2,340
United States (Indians)			108	108	1	1	109	109
British Provinces	3	1	68	10	18	5	89	16
Sweden	14	6	735	109	21	5	770	120
Norway			252	85			252	85
Denmark			9				9	
Germany	2		64	26	11		77	26
Greece			86	33			86	33
Italy			94	79	1		95	79
Russia			610	297	6	2	616	299
Austria			264	181	3	1	267	182
Portugal			45	26	2	2	47	28
France			6	6			6	6
China	2	2	10	10	1,347	1,347	1,359	1,359
Africa			1				1	
Total	53	53	3,045	3,045	1,584	1,584	4,682	4,682

Apparatus and capital employed in the fisheries of Oregon in 1888.

Streams.	Gill nets.		Seines.		Weirs and pound nets.		Salmon wheels.		Value of minor apparatus.
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	
Windchuck River			1	$250					
Chetco River			2	500					
Rogue River	123	$3,675	2	1,700					
Elk River	1	50	1	150					
Sikhs River	2	100	1	150					
Coquille River	150	9,000	9	1,800					
Koos Bay and River	134	6,920							
Umpquah River	45	6,300	1	500	2	$1,000			
Siuslaw River	68	5,100							
Alseya River	52	5,200	2	400					
Yaquina River	75	7,200	2	300	2	500			
Nestuggah River	15	1,125							
Tillamook River	109	9,925	2	460					
Neconicum Creek	3	300							
Columbia River	1,578	262,725	2	1,050	52	40,050	24	$63,613	$2,900
Willamette River	190	5,000							
Total	2,545	322,620	25	7,260	56	41,550	24	63,613	2,900

Streams.	Vessels.				Boats.		Other property.		Total capital invested.
	No.	Tonnage.	Value.	Value of outfit	No.	Value.	Land, buildings, etc	Cash capital.	
Windchuck River					2	$100			$350
Chetco River					4	200			700
Rogue River	3	*190.58	$26,000	$1,500	25	1,300	$40,000	$60,000	134,175
Elk River					1	25			225
Sikhs River					2	175			425
Coquille River					84	3,540	15,800	45,000	75,140
Koos Bay and River	1	85.87	7,500	2,000	43	2,990	20,000	24,000	63,410
Umpquah River					39	2,925	13,000	25,000	48,725
Siuslaw River					68	2,380	12,000	25,000	41,480
Alseya River					43	1,300	9,500	28,000	44,400
Yaquina River					75	3,600	10,000	20,350	41,950
Nestuggah River					15	450	12,000	20,000	33,575
Tillamook River					76	11,200	22,600	49,000	93,185
Neconicum Creek					3	225	800	1,500	2,825
Columbia River	9	145.85	40,550	7,900	1,025	169,885	463,594	655,000	1,707,267
Willamette River					40	800			5,800
Total	13	422.30	74,050	11,400	1,545	201,095	619,294	952,850	2,296,632

* Tonnage partly estimated.

Products of the fisheries of Oregon in 1888.

Streams.	Fish sold fresh.				Fish salted.				Value of mollusks, crustaceans, and secondary products.	Total value of products.
	Salmon.		Other species.		Salmon.		Other species.			
	Pounds.	Value.	Pounds.	Value.	Lbs.	Value.	Lbs.	Value.		
Windchuck River					16,000	$640				$640
Chetco River	30,000	$450			73,000	2,920				3,370
Rogue River	1,554,340	31,837								31,837
Elk River	26,000	390			10,000	400				790
Sikhs River	20,000	300			12,000	480				780
Coquille River	734,000	10,860			15,000	600				11,460
Koos Bay and River	745,000	12,975								12,975
Umpquah River	675,000	13,500			72,000	2,880				16,380
Siuslaw River	837,200	12,558								12,558
Alseya River	813,400	12,901								12,901
Yaquina River	500,150	15,005							$6,250	21,255
Siletz River	100,764	3,023								3,023
Nestuggah River	350,000	5,250								5,250
Tillamook River	1,074,310	21,236								21,236
Neconicum Creek	28,000	420								420
Columbia River	15,698,469	811,481	1,019,924	$21,158	327,900	13,395	191,200	$3,974	16,481	866,489
Willamette River	228,609	11,430			7,000	280	10,000	500		12,210
Total	23,415,242	963,616	1,019,924	21,158	532,900	21,595	201,200	4,474	22,731	1,033,574

26. FISHERIES OF THE WINDCHUCK RIVER.

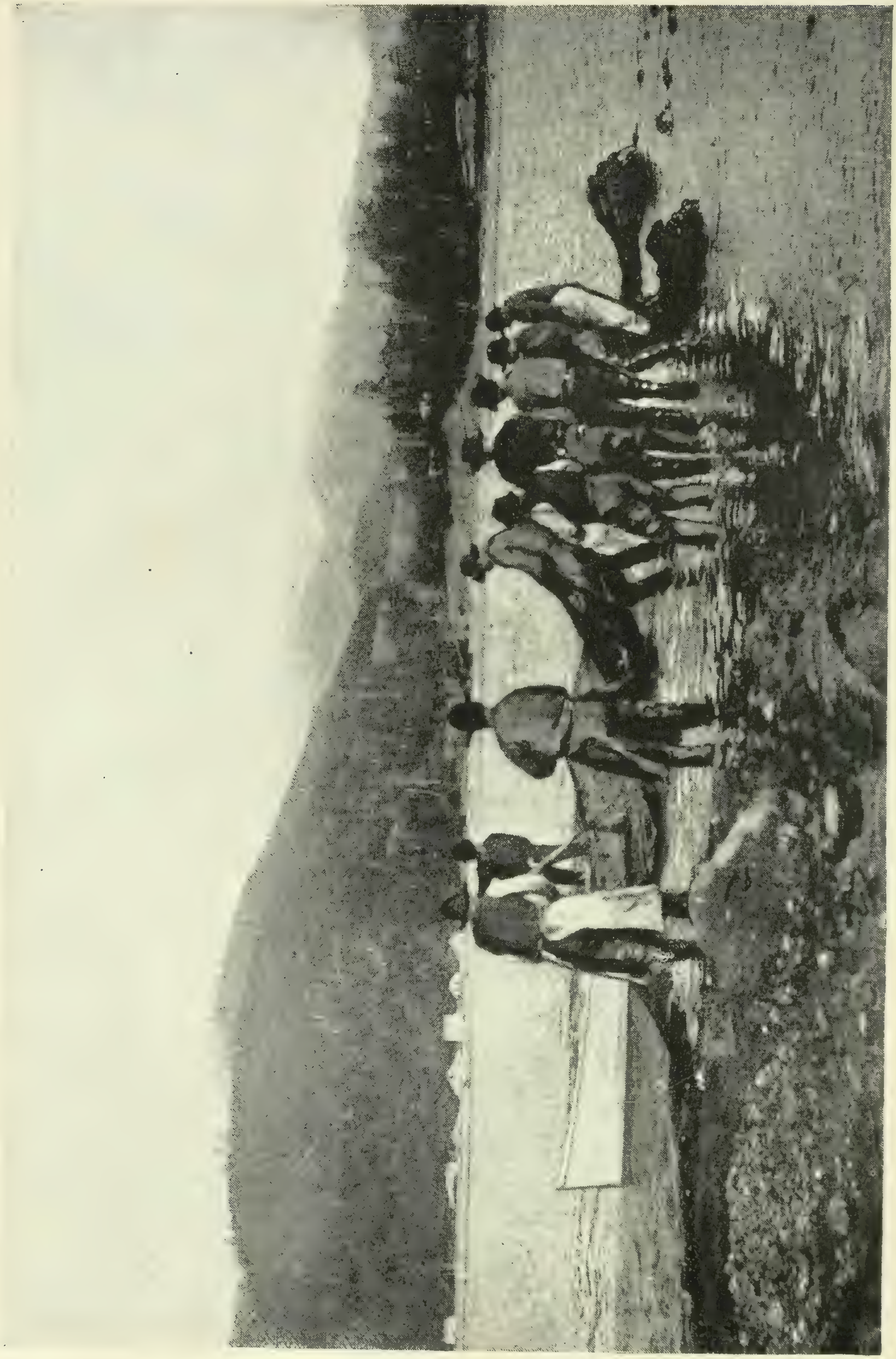
Windchuck River is the southernmost stream in Curry County, Oregon, being located very near the California state-line. It traverses the county for a distance of about 25 miles before reaching the Pacific.

There is only a fall run of salmon. The fishing begins about the middle of September and lasts until the end of November. Several species of salmon are found in this stream—quinnat, silver, steelhead, and blueback. As a rule, bluebacks enter the river after all other species; at times as many as 600 have been taken at one haul of the small seine used on this river. There is no fishery for other species than the salmon, and this is of little consequence, as will be seen by the following statistics for 1888:

Persons employed (nativity and nationality):	
United States	2
Apparatus and value:	
1 seine	$250
2 boats	100
Products and value:	
80 barrels salted salmon	640

27. FISHERIES OF THE CHETCO RIVER.

Chetco River empties into the Pacific a few miles north of the California line, in Curry County, and about 24 miles south from Rogue River; it rises at the base of the Red Peak mountains, in the southern part of Curry County, and flows a distance of about 20 miles to the



SEINING SALMON ON ROGUE RIVER.

ocean. Its fisheries are insignificant, as shown by the table, employing only 30 men in 1888. The fresh salmon shown in the table were sold to a cannery located on Smith River, California.

Persons employed (nativity and nationality):	
United States	15
United States Indians	15
Apparatus and value:	
2 seines	$500
4 boats	200
Products and value:	
365 barrels salt salmon	2,920
30,000 pounds fresh salmon	450

28. FISHERIES OF THE ROGUE RIVER.

Rogue River issues from Crater Lake, in the Cascade range of mountains, on the western border of Klamath County, Oregon, flowing a distance of about 325 miles to the ocean, which it enters at Ellensburgh.

Fishing centers.—The town of Ellensburgh, located near the mouth of the river, is the only center for fisheries. A salmon cannery is located here. The town is entirely dependent upon the fisheries, its inhabitants being employed more or less in this vocation. In every respect it may be called an "industrial town," being founded and maintained through the influence of the fisheries.

Importance of the fisheries.—The salmon fishery of Rogue River ranks third in importance among the river fisheries of the west coast, there being both a spring and fall run of salmon. Fishing is not prosecuted for other species. For many years prior to the establishment of the cannery at Ellensburgh a large amount of salmon was caught and pickled in barrels, but overfishing and the effects of hydraulic mining rendered the industry of little importance until artificial propagation was begun. From the time that the effects of successful artificial propagation were felt the catch and pack of salmon show an annual increase.

The following is a statement of the number of cases of salmon of the spring and fall runs which were packed during the years 1877 to 1889:

Year.	Spring cases.	Fall cases.	Total number of cases.	Year.	Spring cases.	Fall cases.	Total number of cases.
1877	3,197	4,607	7,804	1884	8,202	4,174	12,376
1878	2,402	6,497	8,534	1885	5,442	3,868	9,310
1879	4,038	4,533	8,571	1886	4,299	7,848	12,147
1880	4,142	3,630	7,772	1887*	7,290	9,926	17,216
1881	8,303	4,017	12,320	1888†	13,653	7,409	21,062
1882	15,093	4,093	19,186	1889‡	16,158	....	....
1883	10,337	5,819	16,156				

* 2,000 cases of the fall pack were made from salmon taken in Klamath River.
† 1,000 cases of the fall pack were canned from salmon caught on the Klamath.
‡ The report for 1889 was brought up to August 29, when the fall pack had just commenced. The cannery was closed but 10 days between the ending of the spring pack and opening of the fall pack.

The first attempt at artificial propagation was made in 1878, but on account of inexperience and lack of proper facilities little or no suc-

cess was met with until 1882. It will be noticed that the pack of 1885 was exceptionally low. This result is attributed to the fact that 4 years previously nearly all the spawners that had been held in confinement died, and consequently eggs could not be secured in any numbers. In 1886 the effect of the successful hatching of several hundred thousands of young salmon in 1882 was felt, and from this time on there has been a marked annual increase of important proportions.

It may not be out of place to notice in a brief manner the establishment of Mr. R. D. Hume on this river. Settling on the river with only a wilderness surrounding him, he has, by his indomitable energy, through the medium of the fisheries, built up one of the most complete establishments on the Pacific. In connection with the enterprise has sprung up the small town of Ellensburgh. Mr. Hume's establishment embraces all that pertains to the salmon fishery. There is a cannery for the packing of salmon; sailing vessels and a steamer for transporting the products to market; a hatching establishment and rearing ponds for the propagation of salmon; nets are made here, boats and sails manufactured, the fishermen housed and boarded; a general store, including a medical dispensary, etc., supplies all necessary wants.*

Species, seasons, etc.—There are three varieties of salmon found in the Rogue River, the quinnat, silver, and steelhead;† also the salmon trout, black-spotted trout, sole, sardine, smelt, herring, perch, suckers, lamprey eels, etc. The salmon are the only objects of fisheries, except perhaps the trout, which are sought by anglers more as a pastime than for commercial purposes. The quinnat salmon is the first to enter the river; it arrives about March 1 and continues to run until October 1; a few scattering specimens occur after that date. Silver salmon appear about the middle of September and continue until about the middle of November, though a few may be taken before and after those dates. There is also a large run of steelheads in January and February, which continues into the spring. The average weight of salmon in the Rogue is said to be greater than that of the same species in the Columbia. Of two lots of quinnat salmon of twelve specimens each that were indiscriminately caught and weighed, the first lot averaged $33\frac{1}{2}$ pounds and the second lot $24\frac{1}{4}$ pounds, bringing the average to about 30 pounds. The silver salmon and steelhead average about 8 pounds each.

Fishing grounds.—The grounds upon which the fisheries are prosecuted are all located on the river. On the shores, near the mouth of the stream, seines are hauled, and gill nets and set nets are operated in the river, chiefly below the village.

Fishermen, wages, etc.—The fisheries on the river gave employment in 1888 to 32 Americans, 3 Englishmen, 4 Swedes, 1 Austrian, and 1 negro,

* In another paper, in course of preparation by the Commissioner, more detailed notice will be taken of the propagating work done by Mr. Hume.

† The steelhead, though belonging to the river trouts, is universally called a salmon and for this reason the popular name is used in this report.

making a total of 41 men. In addition, 18 men were employed on the transport vessels; these men are hired by the month and boarded. The pay varies with the position and character of work.

Boats and apparatus.—There are two schooners and a steam vessel employed in connection with the fisheries of Rogue River. These are used to market the products and carry the supplies to the town. The steamer *Thistle*, of 32.58 tons net register, is unique, inasmuch as it has two propellers on one shaft, one astern and one forward. It is claimed that this arrangement facilitates her progress when crossing the bar at the mouth of the river. The small boats used here are mostly of the flat-bottomed, sharpy type. Large flat-bottomed seine boats are used when setting the seine.

Drift nets are 60 to 75 fathoms long and 18 to 20 feet deep, though some have a length of 150 fathoms. The mesh is $8\frac{3}{4}$ inches. Seines range from 140 to 250 fathoms in length, and are 22 feet deep, having a mesh from $3\frac{1}{2}$ to 5 inches. Set nets are 12 to 25 fathoms long, 22 to 24 feet deep, and have an $8\frac{3}{4}$-inch mesh.

Methods of fishing.—The spring salmon are captured chiefly in drift and set nets near the mouth of the river. In the fall seines are fished; these have two sizes of mesh; from July to September a 5-inch mesh is used for the quinnat salmon, and from about the middle of September until the run of steelhead salmon is over, a $3\frac{1}{2}$-inch mesh. There are no pound nets or weirs on the river.

Disposition of products.—The catch of the steelhead (*S. gairdneri*) is shipped fresh to the market at Portland, Oregon. Other species, however, are mostly utilized at the packing establishment for canning purposes, although a few are occasionally shipped to markets at San Francisco and elsewhere in a fresh state. The canned products are sent by steam and sailing vessels for disposition at San Francisco, etc.

Salmon canning.—In 1888 the canning establishment on the river employed 106 factory hands; utilized 1,404,340 pounds of fresh salmon, worth $28,087, and manufactured 21,062 cases, valued at $121,107.

Statistics.—The following tables show the statistics of the fisheries of Rogue River in 1888:

Persons employed.

Country.	Fishermen.		Shoresmen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	35	52	39	52
United States (Indians)	....	....	1	1
British provinces	5	1	8	....
Sweden	17	6	4	....
Austria	1	....	1	....
China	....	....	53	53
Africa	1	....	....	....
Total	*59	59	106	106

* Including 18 persons employed on fishery transports.

Apparatus and capital.

Designation.	Number.	Value.
Vessels (tonnage, 190.58)	3	$26,000
Outfit		1,500
Boats	25	1,300
Seines	2	1,700
Gill nets	123	3,675
Shore property		40,000
Cash capital		60,000
Total		134,175

Products and values.

Species.	Pounds.	Value.
Salmon used for canning	1,404,340	$28,087
Salmon shipped fresh	150,000	3,750
Total	1,554,340	31,837

29. FISHERIES OF THE ELK RIVER.

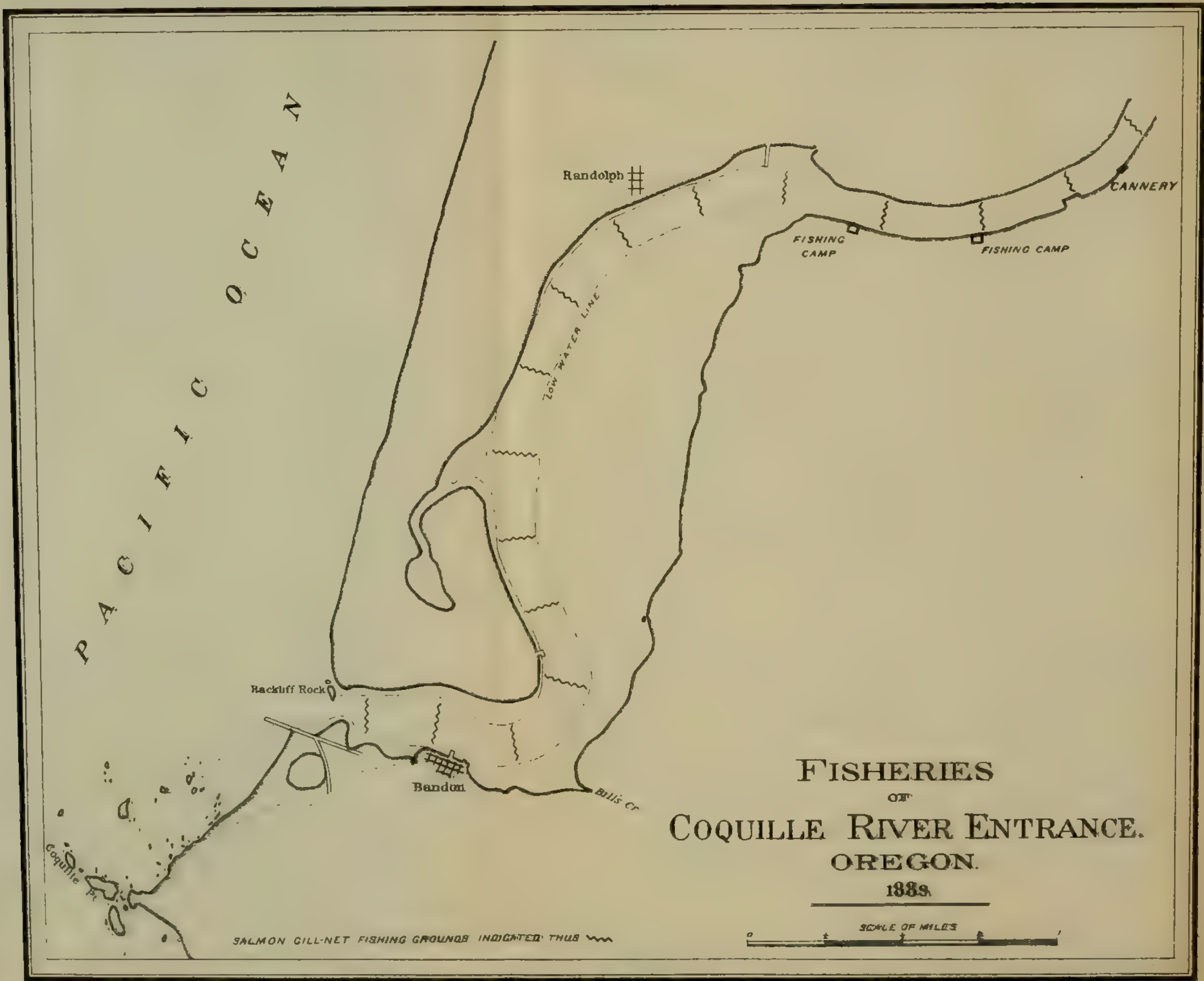
This stream is located in Curry County, Oregon, and empties into the Pacific about 2½ miles south of Cape Blanco. It rises in the mountains in the interior of the county and flows a distance of about 40 miles in a westerly direction to the Pacific Ocean. It is quite narrow, and its fisheries can never be of much importance.

Three kinds of salmon are taken in this river—chinook or quinnat, silver, and steelhead; salmon trout, black-spotted trout, smelt, herring, perch, flounders, and suckers occur, but are not of economic importance at the present time. Salmon appear only in the fall, and are taken, as a rule, from the mouth of the river to the head of tide water, a distance of about 1 mile.

Most of the catch of 1888 was sold to the salmon cannery on the Coquille River, and has been included in the pack of that stream. Such salmon as can not be shipped to the cannery in a fresh condition are salted and packed in barrels. The first shipment of that character was in 1880, and since then small shipments have been made annually. In 1887 180 barrels and in 1888 50 barrels of salted salmon were put up and sent to market.

The statistics of the fisheries on this river in 1888 are as follows:

Persons employed:	
By nativity—	
United States	4
British provinces	1
By nationality—	
United States	5
Apparatus and values:	
Boat	$25
Seine	150
Gill net	50
Products and values:	
26,000 pounds fresh salmon	390
10,000 pounds salted salmon	400


PACIFIC OCEAN
Randolph
CANNERY
FISHING CAMP
FISHING CAMP
LOW WATER LINE
Rackliff Rock
Bandon
Bills Cr.
Coquille Pt.
FISHERIES
OF
COQUILLE RIVER ENTRANCE.
OREGON.
1888.
SCALE OF MILES
0
¼
½
¾
1
SALMON GILL-NET FISHING GROUNDS INDICATED THUS

30. FISHERIES OF THE SIKHS RIVER.

This is another of the small rivers, which are so numerous along the coast of Oregon. It is located in the northern part of Curry County, flowing a distance of about 40 miles and entering the Pacific 1½ miles, north of Cape Blanco.

Practically the same species of fish occur in the Sikhs as in the Elk River. The salmon run begins about October 1 and continues until December; the best catches are made between October 15 and November 15. The chinook salmon in this stream are large, averaging about 30 pounds. The silver salmon are also large for that species, averaging about 15 pounds.

The fishing grounds are, for the most part, at the mouth of the river and do not extend a great distance upstream. The products in 1887 were 225 barrels of salted salmon. In 1888, 20,000 pounds of fresh salmon were sold to the cannery on the Coquille River, and the remainder of the catch, amounting to 60 barrels, was salted.

The statistics of the fisheries of this river in 1888 are as follows:

Persons employed:	
By nativity—	
United States	6
British provinces	1
By nationality—	
United States	7
Apparatus and capital:	
2 boats	$175
2 gill nets	100
1 seine	150
Products and values:	
1887—Salted salmon, 45,000 pounds	1,800
1888—Fresh salmon, 20,000 pounds	300
Salted salmon, 12,000 pounds	480

31. FISHERIES OF THE COQUILLE RIVER.

Coquille River (called *Nessa-til-cut* by the Indians) is formed by three branches, called the North, Middle, and South Forks, which rise in the Umpquah Mountains. The "Forks" unite near Myrtle Point, the head of tide water, about 45 miles by river from the mouth of the stream, the distance by land being about 15 miles. It is a deep and sluggish stream, well timbered on its banks. There are no natural obstructions, such as rapids, falls, or dams, on the river to hinder the free passage of fish.

Origin and development of the fisheries.—The first salmon cannery constructed on the Coquille was erected in 1883, at Parkersburgh. In 1886 another was built at the same place, and the following year the town of Randolph was selected as a site for a third. Prior to the erection of the salmon canneries the catch at different places along the river was salted and packed in barrels. The earliest recorded instance of any considerable quantity being packed was in 1877, when 3,000 barrels of salmon were pickled and shipped to San Francisco. Since then, and until the construction of the first cannery, there was an an-

nual shipment of about 3,000 barrels. At present the catch is nearly all disposed of to the canneries, but in case a surplus is obtained it is usually salted.

Fishing centers.—The principal distributing point is Bandon, whence all shipments to San Francisco, or up the coast, are made. At this point there is a wharf for steamboats, by means of which only is this place accessible. Fishing stations or camps are located along the river for a distance of about 8 miles above Bandon. At these camps the fish are collected, and either shipped fresh to the canneries, or salted, barreled, and sent to Bandon for shipment to San Francisco.

Importance of the fisheries.—The total capital invested in the fisheries on this river in 1888 was $75,140, including boats, seines, gill nets, canneries, horses, etc. There are three canneries on the river, but in 1888 only two were in operation. These employed 40 hands in all. The men engaged in catching fish for the canneries numbered 222. The products for 1887 amounted to $13,800, and in 1888 to $11,460, not including the value of fresh salmon purchased by the canners from the fishermen of adjacent streams.

Species, seasons, etc.—There is a variety of anadromous and local species in the Coquille, many of which are found only near its mouth, where the water is salt or brackish. Quinnat, silver, and steelhead salmon, salmon trout, shad, sardines, smelt, anchovies, herring, sturgeon, sole, flounders, tomcod, perch, and suckers occur in abundance at proper seasons. The salmon run usually begins about September 1, though it is said that in previous years the season began as early as the 1st of August. The quinnat is the first salmon to appear, and the run generally lasts until October. About the middle of September silver salmon and steelheads (though very few of the latter are taken) arrive and continue until about the middle of October.

Shad first made their appearance in the Coquille River during 1884, when a few were caught. Since that year there has been an annual increase in the number taken, and 30 shad were caught in one haul of a salmon seine in 1889.

Fishing grounds.—The seining and gill net reaches extend from the mouth of the river to Myrtle Point, about 45 miles inland. From below Bandon to a short distance above Randolph gill nets are set entirely on the left side of the river, while above Randolph they reach from one side of the stream to the other, completely closing it to the passage of fish.

Fishermen, lay, etc.—A number of Columbia River fishermen annually pursue the fall fishing on the Coquille River; 38 men were so engaged in 1888 and 55 in 1889. The catch is purchased by the piece at the canneries, the prices are 60 cents each for quinnat and 40 cents for silver salmon. The boats and nets are owned partly by the fishermen and partly by the canners, who let them to the fishermen on condition that one-third of the catch shall be given for the use of the apparatus.

Boats and apparatus.—The boats are all flat-bottomed "skiffs," with


PACIFIC OCEAN
North Slough
Hayne's Slough
Russell Pt.
North Bend Pt.
Jordan's Slough
Pirney Pt.
Pony Slough
Pierce's Pt.
Cooper's Pt.
Empire City
CANNERY
CANNERY
Marshfield Channel
Marshfield Pt.
White Pt.
Kitchen Slough
KOOS RIVER
Isthmus Slough
Coalbank Slough
Pigeon Pt.
Koos Head
Cape Gregory
SOUTH SLOUGH
U. S. Commission of Fish and Fisheries,
Marshall McDonald, Commissioner.
CHART
SHOWING THE LOCATION
OF THE
FISHERIES IN KOOS BAY, OREGON.
SEASON OF 1889.
SALMON GILL-NET FISHING GROUNDS INDICATED THUS

P A C I
Koos Head
Cape Gregory
SOUTH SLOUGH
22'
43°
20
22
124°
20

sharp bow and square stern, and average from 18 to 20 feet in length, having about 5 feet beam.

The gill nets are 70 fathoms long and 16 to 17 feet deep, with a $7\frac{1}{2}$ to $8\frac{3}{4}$ inch mesh. The seines average from 130 to 140 fathoms long, 18 to 20 feet deep, the mesh being $4\frac{1}{2}$ inches in the bunt and 5 inches in the wings. Seines and gill nets are made by the fishermen.

The statistics of the fisheries in this river in 1888 are as follows:

Persons employed.

Country.	Fishermen.*		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	36	117	4	4
Sweden	75	32		
Norway	50	27		
Russia	60	45		
Portugal	1	1		
China			36	36
Total	222	222	40	40

*Of these, 38 were from the Columbia River and are reported from there.

Apparatus and capital.

Designation.	No.	Value.
Boats	84	$3,540
Gill nets	150	9,000
Seines	9	1,800
Buildings, machinery, etc		15,800
Cash capital		45,000
Total		75,140

Products and values.

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Salmon, fresh	840,000	$12,600	734,000*	$10,860
Salmon, salt	30,000	1,200	15,000	600
Total	870,000	13,800	749,000	11,460

* This quantity, together with the fish purchased from outside fishermen, was utilized in the manufacture of 11,000 cases of canned salmon, valued at $63,250.

32. FISHERIES OF KOOS BAY AND RIVER.

Koos River proper is an unimportant stream. Rising in Koos County, at the base of the Umpquah Mountains, it flows in a northwesterly direction for a few miles, and empties into what is known as Koos Bay, a navigable inlet of the ocean, having numerous arms or branches. Koos Bay, after being joined by Koos River, describes almost a semicircle, its course lying in a northwesterly direction for about half the distance, whence it turns, almost abruptly, to the southwest, until it reaches the ocean. There is much marshy ground in the bay, and a number of so-

called sloughs, or small creeks, which empty into the bay from both sides. Taking the left side of the bay at the point where it is joined by the river, and passing around its shore, there are Kitchen Slough, Isthmus Slough, and Coalbank Slough, all of which are directly west of the mouth of Koos River. Leaving the last-named slough, the shore line trends to the north until North Point is reached, a sort of peninsula jutting out into the bay. Here Poney Slough enters the bay and the shore line takes a decided bend to the southwest; near the point where the bay enters the ocean it is joined by South Slough. On the right bank Jordan's Slough, Haynes's Slough, and North Slough enter the bay, the latter being its northernmost arm.

Importance of the fisheries.—The fisheries here are of minor importance, employing 90 fishermen, 46 persons in canneries, $61,410 capital, and producing 1,041,000 pounds of fresh salmon in 1887 and 745,000 pounds in 1888, worth (at the prices paid the fishermen), respectively, $16,865 and $12,975.

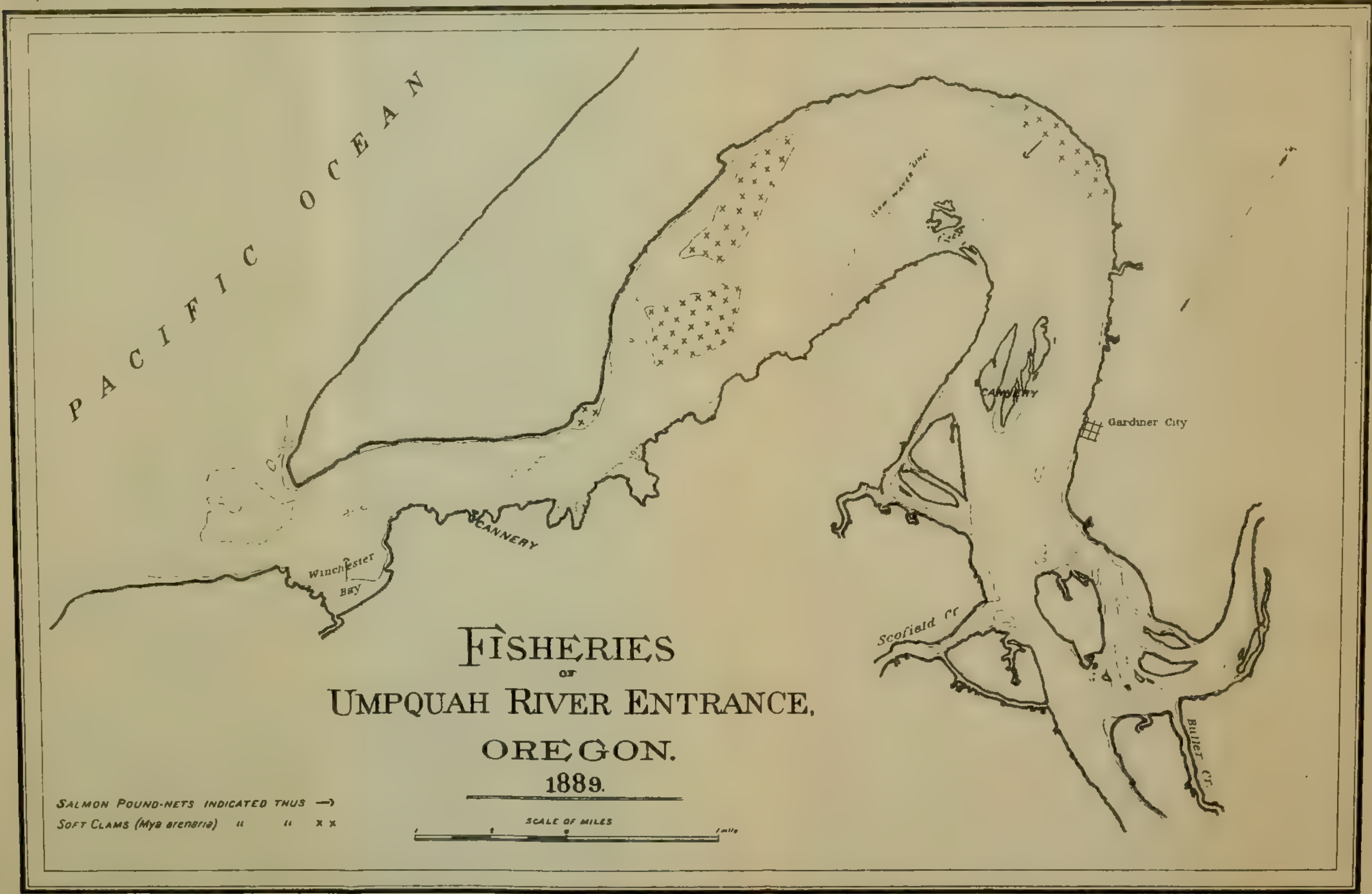
Species, seasons, etc.—Quinnat, silver, and steelhead salmon, salmon trout, herring, smelt, sardines, rockfish, perch, sturgeon, tomcod, sole, and flounders are found in the bay, but only the salmon are sought for capture. Salmon are most abundant from the middle of August until November. The quinnat is the first to appear, and is quite numerous until about the middle of September. The season for the silver salmon is between September 15 and October 15.

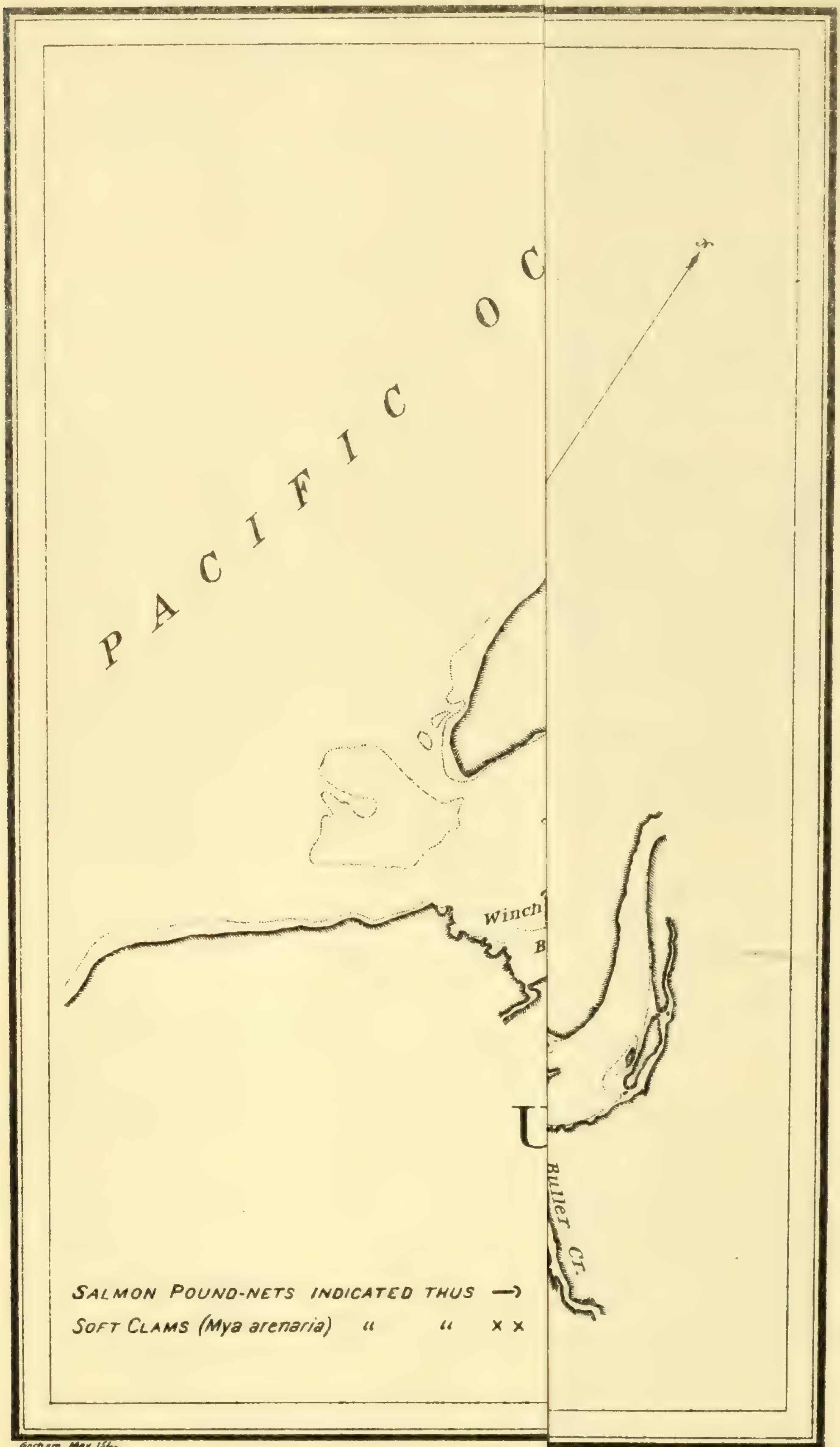
Fishing grounds.—Drift nets are set in the bay from its mouth to Koos River, a distance of about 15 miles; set nets are exclusively used in the river above the point where it joins the bay, the fishing grounds extending nearly 12 miles up the stream.

Fishermen, lay, etc.—In 1888 there were 90 men engaged in fishing on the bay and river; 28 of them were native-born Americans, 20 Russians, 16 Swedes, 12 English, 10 Norwegians, and 4 Frenchmen; 28 of them came from the Columbia River after the close of the season on that stream. The price paid the fishermen was 50 cents each for quinnat salmon and 30 cents for silver salmon.

Apparatus, boats, etc.—The drift nets are from 150 to 250 fathoms, averaging 175 fathoms in length, and about 30 meshes, or 3 fathoms, deep; several sizes of mesh are used, being 7½, 8½, and 9 inches (stretch measure), respectively. Set nets average 50 fathoms in length and from 3 to 4½ fathoms deep; the mesh varies from 7½ to 9 inches. Two kinds of boats are in use on the bay and river, one type being the Columbia River salmon boat and the other a sharp-bow and square-stern, flat-bottomed craft, much like a bateau or sharpy. The two types are about evenly distributed among the fishermen.

Salmon canning.—There are two salmon-canning establishments on the bay; one is situated at Empire City, near the mouth of the bay; the second is near the mouth of the river. Both began operations in 1887, the output of products for that year being 11,300 cases of canned salmon.


PACIFIC OCEAN
LOW WATER LINE
CANNERY
Gardiner City
CANNERY
Winchester Bay
Scofield Cr
Bullet Cr.
FISHERIES OF UMPQUAH RIVER ENTRANCE, OREGON. 1889.
SALMON POUND-NETS INDICATED THUS
SOFT CLAMS (Mya arenaria) " " x x
SCALE OF MILES
1 mile


PACIFIC OC
Winch
B
U
Buller Cr.
SALMON POUND-NETS INDICATED THUS
SOFT CLAMS (Mya arenaria) " " x x
Gorham May 15/90

During 1888 but one cannery was in operation, the pack being 5,500 cases. The operations of this establishment gave employment to 46 factory hands in addition to the fishermen who supplied the raw products.

The following tables exhibit the condition of the fisheries in Koos Bay and River in 1888. For purposes of comparison, the yield in 1887 is also added.

Persons employed.

Country.	Fishermen.*		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	28	57	2	2
British Provinces	12	6	3	3
Russia	20	14	1	1
France	4	4		
Sweden	16	5		
Norway	10	4		
China			40	40
Total	90	90	46	46

*Of the fishermen, 28 came from the Columbia River after the close of the season on that stream. In the total tables for the State they have been included under that river, where they properly belong.

Apparatus and capital.

Designation.	No.	Value.
Steamer (tonnage, 85.87)	1	*$9, 500
Boats	43	2, 990
Drift nets	26	2, 600
Set nets	108	4, 320
Shore property		20, 000
Cash capital		24, 000
Total		63, 410

* Including outfit, provisions, fuel, etc.

Products and values.

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Salmon sold to canneries	791, 000	$11, 865	385, 000	$5, 775
Salmon sold in local market	250, 000	5, 000	360, 000	7, 200
Total	1, 041, 000	16, 865	745, 000	12, 975

33. FISHERIES OF THE UMPQUAH RIVER.

With the exception of the Columbia this is the longest and largest river in Oregon. It is formed by north and south forks, which rise in the eastern part of Douglas County, emanating from melting snows and mountain springs. The forks unite about 9 miles northwest of Roseburgh, and the river then flows northwestward through a fertile valley and enters the Pacific about 22 miles north of Empire City.

Species, seasons, etc.—The most important species in this river are the three varieties of salmon—quinnat, silver, and steelhead. Salmon trout, black-spotted trout, shad, herring, smelt (two species), tomcod,

perch, flounders, and sole are also found here, all but the first three in salt or brackish water near the river's mouth. Salmon trout and black-spotted trout are plentiful in the upper river, though there is little or no fishing for them.

Shad have made their appearance in this stream, but only a few have been caught. The first catch was in 1888, when 13 were taken at one haul in a salmon net.

Three species of clams are found here—the razor clam, hard-shell clam (*Tapes* [*Cuneus*] *staminea*), and the soft-shell clam (*Mya arenaria*). These abound both on the sea beaches and inside the mouth of the river. However, the *Mya* is found more particularly in the latter-named location. It is claimed that the latter was transplanted to the Pacific in 1884 by Capt. Robert Simpson, who introduced it into this river as well as in Koos Bay. From all that can be learned it thrives in this locality and is becoming very abundant.

A few salmon enter the river in the spring, but never appear in large numbers at that season. Special attention is given to what is known as the "fall run," which begins about the first of August and continues until November. The quinnat is the first species caught, and it is numerous until about the middle of September; only a few are taken after that time. Silver salmon begin to arrive about the middle of September, and are caught as late as the middle of November, though the migration is at its height during October. The quinnat or chinook salmon of this river varies but little from that of the Columbia; the average weight is 25 pounds, some weighing 50 or 60 pounds.

Fishermen, lay, etc.—A large proportion of the fishermen are non-residents. As a rule they operate on the Columbia River until the close of the season, when they leave that locality and transfer their equipment to the Umpquah in sufficient time to get the large run of fish. During the season of 1888 the fishermen received from the canners 40 cents each for quinnat, and 25 cents each for silver salmon. The "lay" is the same as on the Columbia.

Apparatus, boats, etc.—Drift nets, set nets, drag seines, and pound nets are used. Drift nets have an average length of 175 fathoms, are about 2½ fathoms deep, and have a mesh varying from 7½ to 9¼ inches. Set nets are from 100 to 150 fathoms long, about 30 meshes (2½ fathoms) deep, with mesh 7¼ to 9¼ inches. Seines are 250 fathoms long, 24 feet deep in the bunt, and 10 feet in the wings. All nets are made by the fishermen. The pound nets are similar to those on the Columbia.

The boats are mostly of the Columbia River type.

Methods of fishing.—Fishing is not commonly prosecuted during the daytime, except with pound nets; the water is generally much too clear for using gill nets, except at night; if, for any reason, the water is muddy, fishing with gill nets is continued during the day. The methods of operating pound nets and gill nets are similar to those employed on the Columbia.

Disposition of products.—Much good fish food obtainable on the Umpquah is not utilized on account of the lack of transportation facilities. The catch is now chiefly sold to the canners and the surplus salted and packed in barrels; but with quick transportation to some ready market, the fishermen would be able to realize a much greater profit than they now obtain. In 1888, 675,000 pounds of fresh salmon were used at the cannery, and 360 barrels of salted salmon were packed, the whole having a value of $16,380.

Salmon canning.—There are two canneries located on the Umpquah; one on an island opposite the town of Gardner, and the other about 1½ miles from the mouth of the river. The latter has not been in operation since 1884. The pack of the cannery near Gardner was 4,000 cases in 1887 and 9,000 cases in 1888.

The tables show the extent of the fisheries of this river in 1888:

Persons employed.

Country.	Fishermen.*		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	28	47	3	5
United States (Indians)	10	10		
Norway	2			
Germany	12	5		
Great Britain	2	2		
Sweden	14	6	2	
Russia	2	2		
Austria	6	4	1	1
Portugal	2	2	2	2
Italy	2	2		
China			43	43
Total	80	80	51	51

* The figures include 42 persons from the Columbia River, who are shown here to make the statistics complete, but are omitted in the general tables and included in the Columbia River statistics.

Apparatus and capital.

Designation.	No.	Value.
Boats	39	$2,925
Set nets	18	2,250
Drift nets	27	4,050
Drag seines	1	500
Pound nets	2	1,000
Building, machinery, etc		15,000
Cash capital		25,000
Total		50,725

Products and values.

Species.	Quantity.	Value.
Salmon, fresh .... pounds..	675,000	$13,500
Salmon, pickled .... do....	72,000	2,880
Total	677,000	16,380

34. FISHERIES OF THE SIUSLAW RIVER.

The Siuslaw River has its source in the Umpquah Mountains in Lane County, Oregon. Its course lies first in a northwesterly direction and thence to the westward until the Pacific is reached. It is the dividing line of Lane and Douglas Counties. A sand bar at its mouth prevents navigation by all but light-draft vessels. The stream is navigable by such craft for 20 miles inland.

Importance of the fisheries.—The fisheries on this river are pursued for the sole purpose of supplying fish to salmon-canning establishments located upon it, which utilize the entire catch.

Species, abundance, etc.—There is a variety and an abundance of both anadromous and local species, though no attention is given to other than salmon, of which the quinnat and silver varieties occur. The season for salmon opens about the first of August and fishing is prosecuted until November, about which time the migration is completed.

Fishing grounds.—The salmon grounds extend from near the mouth of the river to about 20 miles up stream.

Salmon canning.—There are two factories located on the river, one at the town of Florence and the other a mile or so farther up the stream. In 1888 both these establishments united their interests, using the upper factory; the total output amounted to 11,960 cases of canned goods. During 1889 the arrangement of the previous year was observed, the cannery at Florence being operated.

The fisheries of this river in 1888 are given in the accompanying tables. The output in 1887 is added for purpose of comparison.

Persons employed.

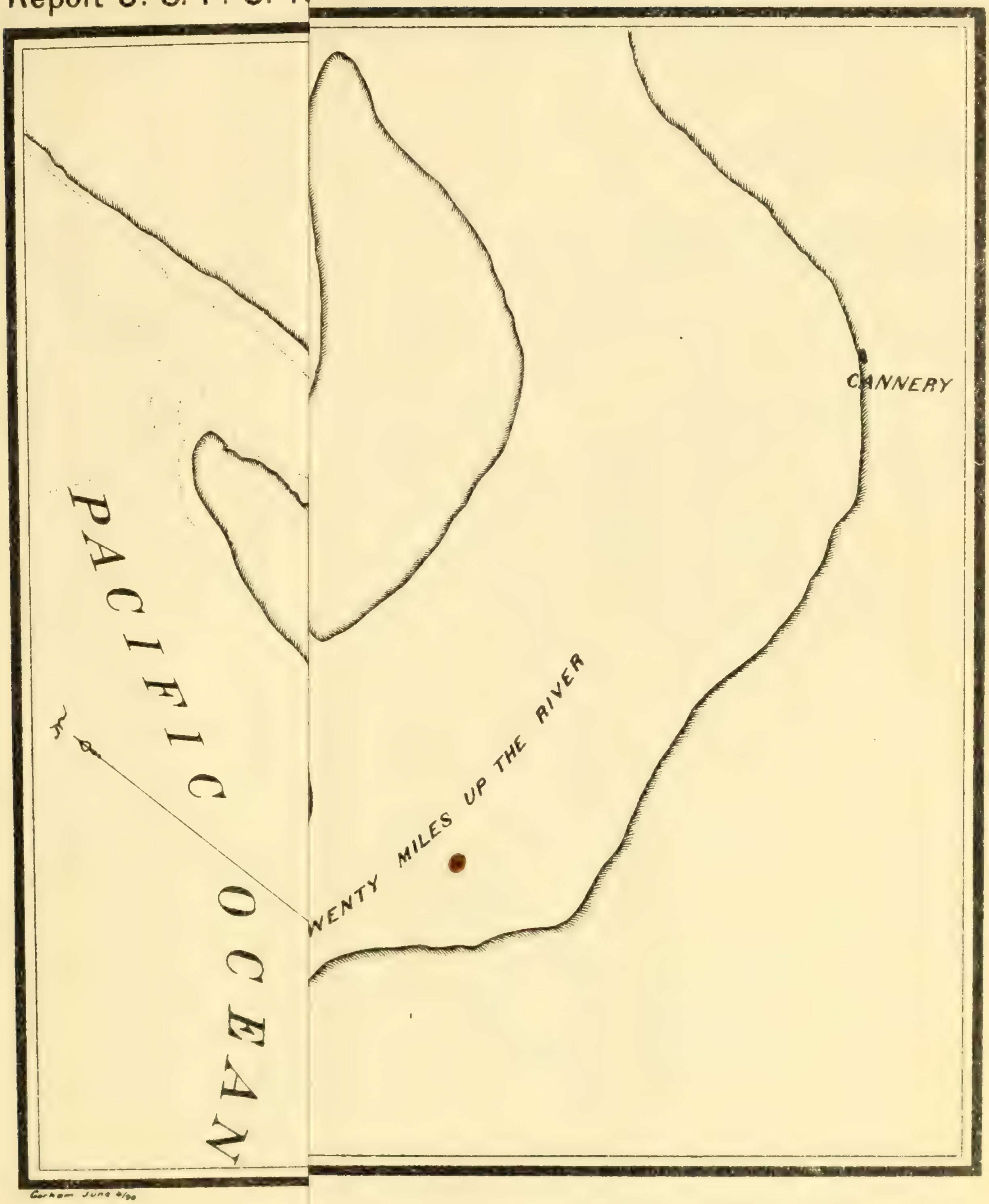
Country.	Fishermen.		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	72	104	4	4
Sweden	18	8		
Russia	22	14	1	1
Italy	2	2		
Germany	22	8		
China			40	40
Total	136	136	45	45

Apparatus and capital.

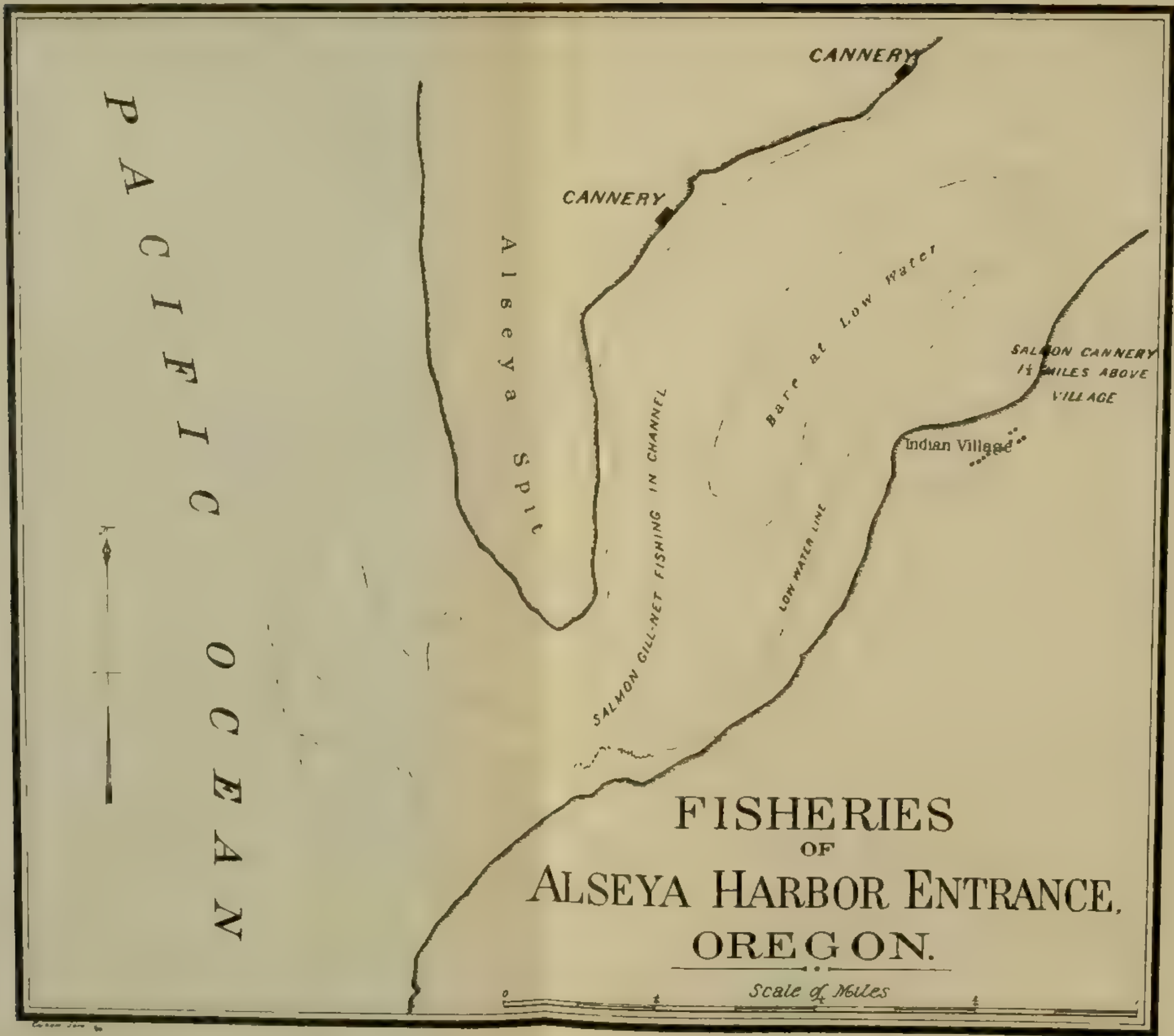
Designation.	No.	Value.
Boats	68	$2,380
Nets	68	5,100
Buildings, machinery, etc		12,000
Cash capital		25,000
Total		*44,480

* Not including one cannery temporarily idle in 1888, valued at $12,000.

PLATE XXVII.




FISHERIES
OF
SIUSLAW RIVER ENTRANCE.
OREGON.
Scale of Miles.
PACIFIC OCEAN
LOW WATER LINE
SALMON FISHING WITH GILL-NETS AND SEINES FOR A DISTANCE OF TWENTY MILES UP THE RIVER
Florence
CANNERY
CANNERY



FISHERIES
OF
ALSEYA HARBOR ENTRANCE,
OREGON.

Quantity and value of salmon.

Year.	Pounds.	Value.
1887	1,260,000	$18,900
1888	837,200	12,558

35. FISHERIES OF THE ALSEYA RIVER.

Alseya River rises in the southwestern section of Benton County, Oregon, and flows in nearly a northwesterly direction to the Pacific, a distance of about 60 miles.

Importance of the fisheries.—Although this stream is of no great length, its salmon fisheries are quite important. In 1888 813,400 pounds of quinnat and silver salmon were caught, of which 673,400 pounds were utilized for canning purposes, and 140,000 pounds shipped fresh to interior markets. These products had a value of $12,901. The industry gave employment to 92 fishermen and 65 "hands" at the canneries.

Species, seasons, etc.—About the same species of fish occur here as in the Siuslaw and other small streams along the coast, but no fishery is prosecuted for other than the salmon. There are three varieties—quinnat, silver, and steelhead. The first two are most esteemed for canning purposes. There is no spring migration in this river; the fall run begins early in August and continues until about November. The quinnat comes first, followed by the silver salmon which appears about the first week in September. The largest catches are made between September 20 and October 20, when both species are in abundance. The average weight of the quinnat salmon on this river is 25 pounds, though single individuals weighing 60 pounds or more have been taken. Silver salmon average about 12 pounds each.

Fishing grounds.—The best grounds are from the mouth of the river to about 3 miles inland. Gill nets are fished in the channel near the entrance of the river as well as at other suitable localities. There are many places where sweep seines can be used.

Apparatus, boats, etc.—The drift nets are about 100 fathoms long, 3 fathoms deep, and have a 9½-inch mesh when used for quinnat salmon and 7¼-inch mesh for silver salmon. Three haul seines are in use. Pound nets have been experimented with here, but, as was the case with those operated on the Yaquina River, their use was soon abandoned on account of the great quantities of grass which lodged in them and thus prevented the capture of salmon.

The boats are of the flat-bottomed bateau type, sharp at the bow and having a square stern. They average 20 to 22 feet in length and have about 5½ feet beam.

Salmon canning.—There are three canneries located on the Alseya, two near its mouth and the third about 2 miles up the river. Salmon canning on this river was first undertaken in 1886; in 1887 two estab-

lishments were in operation, and three were worked during 1888, but two of them were small and packed only a limited number of cases. In 1887 the products of the canneries amounted to 11,180 cases, and in 1888 the three had a total output of only 9,260 cases. During 1888 the factories paid 50 cents for quinnat and 20 cents for silver salmon.

The fisheries on the Alseya River in 1888 were as follows:

Persons employed.

Country.	Fishermen.		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States, white	58	73	10	16
United States, Indian	3	3		
United States, negro	2	2		
Italy	2	2		
Russia	2	2		
Sweden	11	5		
Norway	10	5		
Germany	4		6	
China			49	49
Total	92	92	65	65

Apparatus and capital.

Designation.	No.	Value.
Boats	43	$1,300
Gill nets	52	5,200
Seines	2	400
Shore property		9,500
Cash capital		28,000
Total		44,400

Products and values.

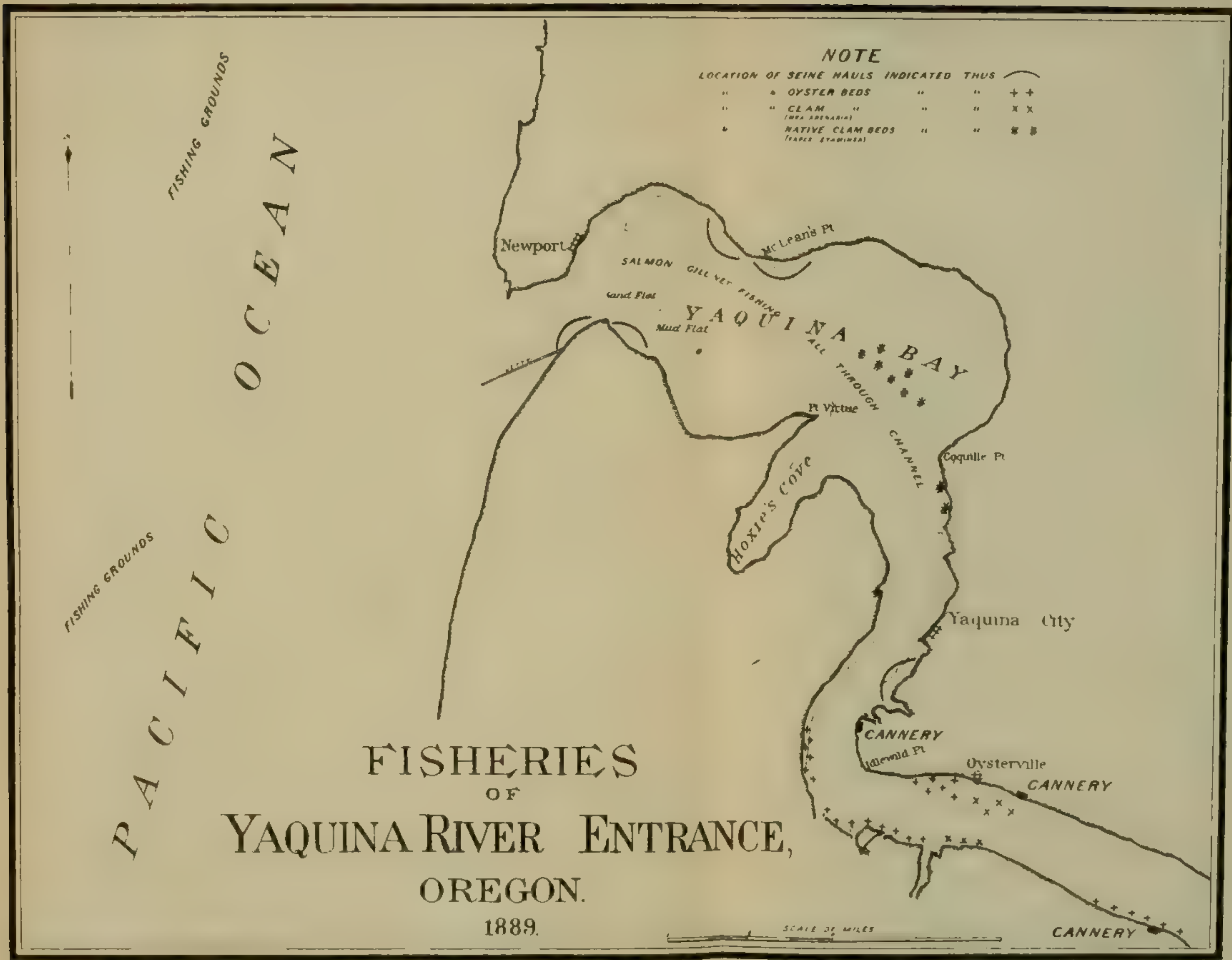
Species.	Pounds.	Value.
Salmon sold to canners	*673,400	$10,101
Salmon shipped fresh	140,000	2,800
Total	813,400	12,901

*Equivalent to 9,620 cases, with a value of $55,315.

36. FISHERIES OF YAQUINA BAY AND RIVER.

The Yaquina ("crooked") River is about 60 miles long; its general course is nearly west through the county of Benton. The river is narrow (from 30 to 40 yards wide) and comparatively unimportant for the greater part of its length. But a few miles from its mouth it suddenly broadens out into an estuary from one-half to three-fourths of a mile wide, which is commonly called Yaquina Bay. For many miles above the "bay" the river has a depth of between 12 and 15 feet, and is therefore navigable for vessels of considerable size. The river empties into the Pacific about 100 miles south of the Columbia. It is a stream

Repo


NOTE
LOCATION OF SEINE HAULS INDICATED THUS
" " OYSTER BEDS " "
" " CLAM " " "
" NATIVE CLAM BEDS " "
FISHING GROUNDS
PACIFIC OCEAN
FISHING GROUNDS
Newport
McLean's Pt
SALMON GILL NET FISHING ALL THROUGH CHANNEL
Sand Flat
Mud Flat
YAQUINA BAY
Pt Virtue
Hoxie's Cove
Coquille Pt
Yaquina City
CANNERY
Idlewild Pt
Oysterville
CANNERY
CANNERY
SCALE OF MILES
FISHERIES OF YAQUINA RIVER ENTRANCE, OREGON.
1889.

of some commercial importance and has a large lumber trade in addition to its fisheries.

Fishing centers.—The fishing centers are all in the lower section of the river and on the "bay." They are Oysterville, Yaquina City, Newport, Toledo, and Elk City. The most important shipping point for fishing products is Yaquina City, which is in direct railroad communication with interior towns. Toledo and Elk City also have railroad facilities.

Importance of the fisheries.—The most important fishery on Yaquina River is that for salmon. Besides the salmon fishery there is quite an industry carried on in native oysters. A few Indians and white men are engaged in a desultory fishery on the banks at sea outside the headlands, though this business is of minor proportions.

In the latter part of 1888 the "Yaquina Deep Sea Fishing Company" was incorporated, the object being to prosecute the sea fisheries off the coast and ship the products to the interior markets. The company purchased the auxiliary steam schooner *George H. Chance*, of 71 tons net register, and in 1889 was reported to be making preparations to actively engage in the business.*

Species, seasons, etc.—The river is bountifully supplied with many varieties of food-fish, as well as oysters and hard and soft shell clams. In addition to salmon the following species of fish occur in the "bay": Rockfish, flounders, sole, perch, bass, herring, smelt, and eels.

About 6 miles from the mouth of the river oysters of the small native species are found abundantly along the shores for a stretch of 4 miles. Atlantic oysters were transplanted to this place at one time and grew rapidly; owing, however, to the fact that but few were planted, and that these were taken up in a comparatively short time, the question of the practicability of successfully propagating them here remains unsettled. Hard and soft shell clams (*Tapes* [*Cuneus*] *staminea* and *Mya arenaria*) occur abundantly along the river shores. The latter species has been known in the locality but a few years and is supposed to have been introduced with the Atlantic oyster.

The salmon season begins the middle of August and lasts until about November. Oysters can not be taken during the close season, which begins June 15 and lasts until September.

Fishing grounds.—The principal fishing ground on which gill nets are used is the channel of the river from its mouth as far up as Elk City, a distance of 25 miles. Sometimes, during pleasant weather, and when the sea is not too rough, the fishermen venture out to sea and set their nets to intercept the salmon on their way to the river. Haul seines

* Since the above was written it has been learned that several untoward incidents or accidents, resulting chiefly from inexperience in sea fisheries, have led to the abandonment of this enterprise. The vessel and the headquarters of the company were transferred to Portland, Oregon, but lack of technical skill and of demand for fish militated against success. It is probable that the attempt to prosecute sea fishing from Portland will not be continued much longer.

are operated at several places along the river. One reach is located just below the cannery on Idlewild Point, one on the east side and another on the west side of McLean's Point, on the north shore of the river, and two others almost directly opposite the latter place. Native clam (*Cuneus*) beds are located on the flats just below Coquille Point, in the "bay." There are also several beds of oysters on both sides of the river near Oysterville, and the eastern clam (*Mya*) is abundant. The sea fishing grounds are located about a mile or so at sea from the harbor entrance. They are believed to be unimportant.

Fishermen, lay, etc.—Seventy-eight men are engaged in the fisheries of this river. As a rule they follow the salmon fishery, though 20 of them engage in the oyster business at the proper season.

A number of the nets and boats are owned by the factory operators, in which case the fishermen receive but 2 cents per pound for all the salmon they take. Where fishermen own the nets and boats the factories buy the catch at the rate of 3 cents per pound.

Apparatus and boats.—The gill nets are from 100 to 125 fathoms in length, 16 feet deep, and have a mesh from 6½ to 9 inches, according to the kind of fish caught. The seines are, for the most part, made from old drift nets. A number of pound nets were put down in 1887, but on account of great quantities of grass fouling them few fish were caught, and their use was abandoned. During 1888 but one pound net and one wooden "trap" or weir were in operation.

The Columbia River salmon boat and the flat-bottomed bateau are used on the river.

Disposition of products.—Most of the salmon taken on the river are sold to the canneries, though a considerable quantity is shipped by express to the interior towns. The canneries purchased 352,344 pounds of salmon in 1888, and 147,806 pounds were forwarded by express in a fresh state.

The products of the oyster fishery are shipped by steamer to San Francisco and by rail to the interior. The shipments average about 60 sacks by steamer and 10 by rail per week. Each sack contains 110 pounds, the wholesale price being $2.50 per sack; retail price, $3.

Salmon canning.—The salmon-canning industry was begun on this river in 1887, when two small factories were started, and a third was built the following year. The total output of these three establishments in 1888 amounted to 5,088 cases. In addition to the salmon taken on the Yaquina River, the canneries purchased 40,764 pounds of salmon from the Indians on the Siletz River Indian Reservation, paying the same price per pound as was given to the fishermen on the Yaquina. The three canneries are located as follows: One on Idlewild Point, below Oysterville, another a short distance above that town, the third on the south side of the stream to the eastward of that place.

The tables which follow give in detail the extent of the fisheries of Yaquina River and Bay in 1888.

Persons employed.

Country.	Fishermen.		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	33	58	6	6
Russia	20	10		
Sweden	15	5		
Norway	8	5		
Italy	2			
China			55	55
Total	78	78	61	61

Apparatus and capital.

Designation.	No.	Value.
Boats	75	$3,600
Gill nets	75	7,200
Seines	2	300
Pound nets and trap nets	2	500
Shore property		10,000
Cash capital		20,350
Total		41,950

Products and values.

Species.	Quantity.	Value.
Salmon .... pounds	500,150	$15,005
Oysters .... sacks	2,500	6,250
Total		21,255

37. FISHERIES OF THE SILETZ RIVER.

This river is included within the limits of the Siletz Indian Reservation and empties into the Pacific about 25 miles north of Yaquina River. It is abundantly supplied with salmon trout and other local species; salmon also occur there in considerable numbers during the migratory or spawning season. None but Indians are allowed to pursue fishing on this stream. The United States Government furnishes them with twine, with which they make their nets. The reservation is populated by 607 Indians, including men, women, and children. During 1888 the Indians captured and sold to the canning establishments on the Yaquina River 40,764 pounds of fresh salmon, for which they received the sum of $1,222.92, or 3 cents per pound. It was estimated by Mr. B. Gaither, the agent at the reservation, that the Indians capture about 60,000 pounds of salmon annually for consumption during the winter months. The fishing carried on by the Indians is of a semi-professional nature, and no figures were obtained covering the personnel, boats, and apparatus of capture.

Products and values.

Species.	Pounds.	Value.	Remarks.
Salmon	40,764	$1,223	Sold to Yaquina River canners.
Do	60,000	1,800	Home consumption.
Total	100,764	3,023	

38. FISHERIES OF THE NESTUGGAH RIVER.

This stream is of small importance so far as its fisheries are concerned. It is located in Tillamook County, Oregon, about 75 miles south of the Columbia River entrance. Its fisheries are confined entirely to salmon, which occur between August 15 and November 1. Quinnat and silver salmon are caught and sold for canning purposes. There is but one salmon-canning factory on this river, which began operations in 1887. The output was 4,300 cases in 1887, and 5,000 cases in 1888.

Statistics.

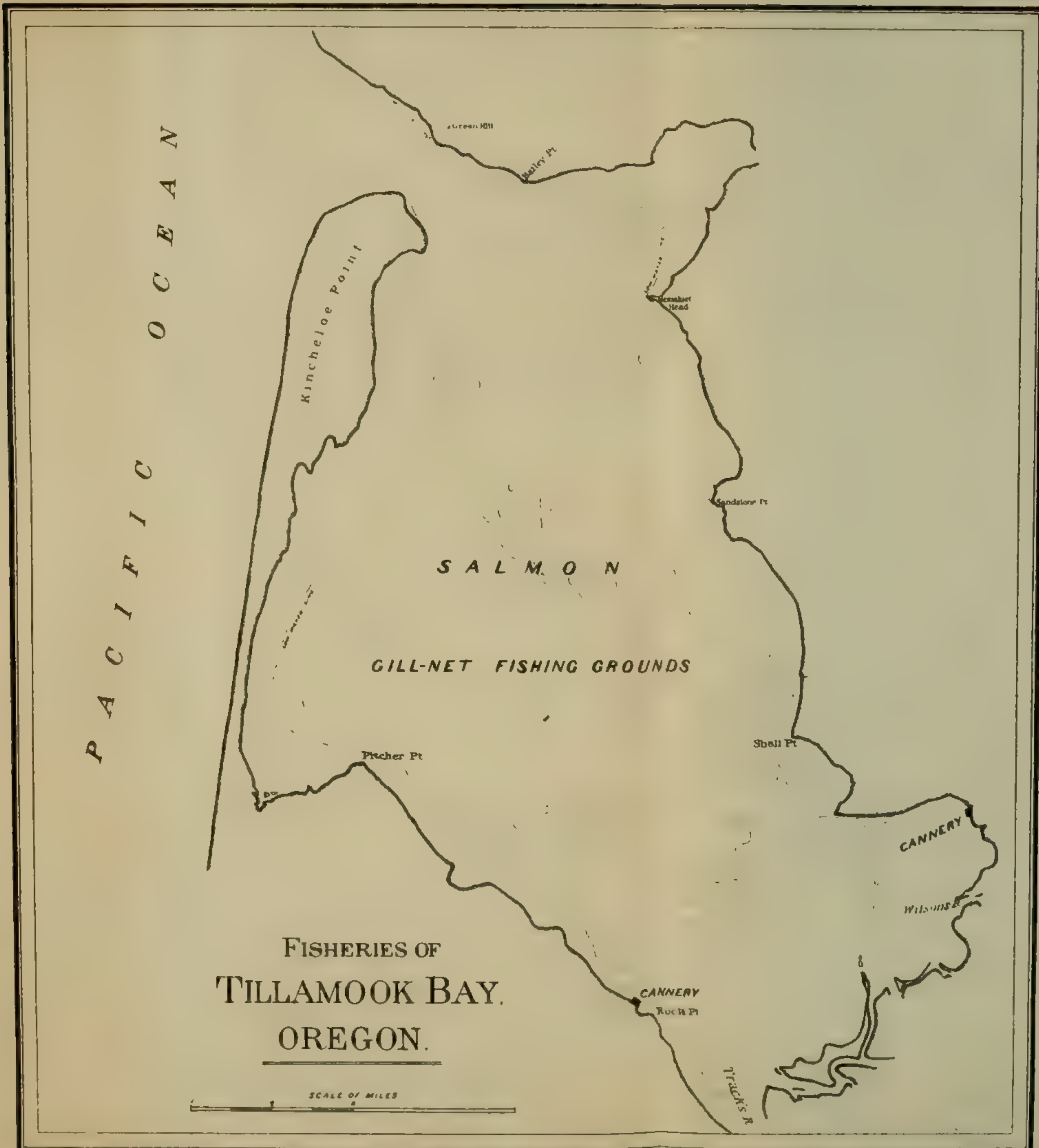
Fishermen employed:	
By nativity—	
United States	5
Austria	15
Russia	10
By nationality—	
United States	15
Austria	10
Russia	5
Factorymen employed (nativity and nationality):	
United States	3
China	35
Apparatus and capital:	
15 boats	$150
15 gill nets	1,125
Shore property	12,000
Cash capital	20,000
Products and value:	
350,000 pounds salmon	5,250

39. FISHERIES OF THE TILLAMOOK RIVER.

Tillamook River is located in Tillamook County, Oregon, and empties into the Pacific Ocean about 45 miles south of the mouth of the Columbia River. The large quantities of salmon which pass into the river during the migratory season make this otherwise insignificant stream an object of noteworthy importance.

Species, seasons, etc.—While numerous species of fish are found in the river, the fishery is limited to quinnat and silver salmon, which enter the stream in about equal numbers during the fall. The fishing begins in August, is at its height in October, and in November the number of fish taken is not large enough to warrant the continuance of fishing. From February to April, large numbers of steelhead salmon enter the river, but as the canning factories are not in operation at that time no attention is given to their capture.

Report U. S. F. C


PACIFIC OCEAN
Kincheloe Point
SALMON
GILL-NET FISHING GROUNDS
Sandstone Pt
Shell Pt
Pitcher Pt
CANNERY
Wilson's R
CANNERY
Rock Pt
Trask's R
FISHERIES OF
TILLAMOOK BAY,
OREGON.
SCALE OF MILES

Fishermen, lay, etc.—154 fishermen were employed on this river during the fishing season of 1888. A considerable number of those who are foreign-born have become naturalized citizens, as will be seen in the tabulated statement. No account of the earnings of individuals was secured, but the aggregate value of salmon taken was $21,236; this would give each man the sum of $138 for the season's work from August until November. The canning factories paid 60 cents for quinnat salmon and 40 cents for silver salmon.

Apparatus and boats.—Drift nets and seines are used to capture salmon. One pound net is located on the river, but was not in operation in 1888. The drift nets are 100 fathoms long and from 22 to 24 meshes deep (about 2 fathoms), and have a mesh varying from 7½ to 9¼ inches. The boats are mostly of the Columbia River type, but a few bateaux are also employed.

Salmon canning.—There are two salmon-canning establishments on the river, one at Garibaldi and the other at Hobsonville, a few miles above. Both are branches of similar establishments at Astoria, Oregon. These canneries employed 12 Americans and 75 Chinamen in 1888. The output was 21,000 cases of canned goods in 1887, and 14,633 cases in 1888.

Statistics of the fisheries of this river are here presented:

Persons employed.

Country.	Fishermen.		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	56	87	12	12
United States (Indians)	10	10		
Austria	48	35		
Russia	26	15		
Sweden	10	4		
Italy	2	2		
British provinces	2	1		
China			75	75
Total	154	154	87	87

Apparatus and capital.

Designation.	No.	Value.
Boats	76	$11,200
Seines	2	460
Gill nets	109	9,925
Shore property		22,600
Cash capital		49,000
Total		93,185

Products and values.

Species.	Pounds.	Value.
Salmon	1,074,310	$21,236

40. FISHERIES OF THE NEHALEM RIVER.

The Nehalem is a small coastal river that rises in the mountains in the southeastern part of Clatsop County, Oregon, and flows southwesterly across the northern part of Tillamook County to the Pacific. A small cannery was in operation on the river during 1887, but not in 1888; its output was 5,000 cases of canned salmon. The fish for canning purposes were caught by fishermen who came from the Tillamook to the Nehalem to engage temporarily in fishing on the latter stream, sending their products across to the canneries they were working for. There was some fishing in this stream in 1888, but the fishermen, their apparatus, and the catch have been included in the statistics for the Tillamook River.

41. FISHERIES OF NECONICUM CREEK.

Neconicum Creek is on the Pacific coast of Clatsop County, Oregon, about 10 miles south of the Columbia River. Its fisheries are of small proportions, and are tributary to the small cannery located on the creek. The entire catch is sold to the cannery, the manufactured product in 1888 being 400 cases. In 1887 the output of the cannery was 600 cases.

Statistics.

Fishermen employed (nativity and nationality):	
United States	6
Factorymen employed (nativity and nationality):	
United States	2
China	6
Apparatus and capital:	
3 boats	$225
3 gill nets	300
Shore property	800
Cash capital	1,500
Product and value:	
28,000 pounds fresh salmon	420

42. FISHERIES OF THE COLUMBIA RIVER.

Although the commercial fisheries of the Columbia River (which are almost wholly confined to the salmon industry) are prosecuted on both sides of the stream and in different States,* it is difficult and seemingly inexpedient to limit their discussion here by any consideration of State boundaries. To do this would involve a great deal of unnecessary duplication of statement. In the statistical tables that appear elsewhere the respective interests of the States are presented; but the description here, so far as it relates to the different phases of the fisheries, has essentially the same application to one side of the river as to the other. Indeed, there is an almost inseparable commingling of interests between

* At the time the investigation was made upon which this report is based Washington was still a Territory, but it became a State in such a short time thereafter that it is deemed best to consider it as such here.


U.S. Commission of Fish and Fisheries
Marshall McDonald, Commissioner.
CHART OF THE
COLUMBIA RIVER
FROM THE
OCEAN TO PORTLAND, OREGON
ILLUSTRATING THE
CONDITION OF THE SALMON FISHERY, SEASON OF 1888-9.
SHOWING IN DETAIL THE LOCATION OF THE
POUND-NETS, WEIRS, SEINE-HAULS, GILL-NET
GROUNDS, AND CANNERIES.
PACIFIC OCEAN
SALMON GILL-NET GROUNDS
GRAY'S BAY
YOUNG'S BAY
ASTORIA
8 CANNERIES
3 CANNERIES
Upper Astoria
CLATSOP SPIT
PEACOCK SPIT
CATHLAMET BAY
SALMON GILL-NETS
PRAIRIE CHANNEL
LONG ISLAND
SALMON GILL-NET GROUNDS
Knappton CANNERY
Chinook CANNERY
Pillar Rock CANNERY
Brookfield CANNERY
Bay View CANNERY
Ilwaco CANNERY
DEER ISLAND
MARTINS I.
Deer Island Slough
KALAMA
CONTINUATION O

Oregon and Washington. In many instances canneries and apparatus operated on one side of the river are owned and controlled by capitalists residing on the other side, while fish taken in the waters of one State are caught by the fishermen of the other, who carry them to the canneries across the river, or otherwise, as the case may be. For the sake of clearness a summation of the combined fishery interests of both sides of the river is given in this chapter, together with a statement of the extent of the fisheries prosecuted from Oregon alone.

Geographical.—The Columbia River rises in British Columbia, flows through Washington, reaching the northern border of Oregon about 75 miles west of its eastern boundary; from this point the river forms the dividing line between Oregon and Washington, its general course being westerly. It empties into the Pacific at Cape Disappointment. Its principal tributaries are the Snake and Willamette Rivers, but Day's and Des Chutes Rivers are streams of some note. The Columbia is the largest river of the west coast; it is most favorably situated for the fisheries, and its headwaters constitute excellent breeding grounds for the salmonidæ.

Fishing centers.—The great fishing center on the Columbia, and the only one of marked commercial importance, is Astoria, Oregon. All other so-called fishing centers, excepting the Cascades and The Dalles, are small settlements that have grown up around the canneries. Astoria is not only the headquarters of the salmon-canning industry, but it is in all essentials a fishery center, since it is the home of a very large proportion of those persons who are engaged in fishing on the river, and is also the principal shipping point of the region.

The city is located about 15 miles from the mouth of the Columbia. It is historically interesting as being one of the first settlements on the Pacific coast, and its intimate association with the salmon industry has given it a peculiar importance in connection with the fisheries of this region. It has held the foremost position as a packing and shipping point, but in very recent years the decline in the abundance of salmon in the Columbia and the increased activity in salmon packing in Alaska have had a marked influence upon the prosperity of the town. Thus in 1887 there were 17 canneries at Astoria, while in 1888 there were but 14 canneries, and in 1889 only 11 packing establishments in active operation. In the meantime 6 firms that had formerly carried on business at Astoria removed their entire plants to Alaska. A few of the firms that still continue operations at Astoria also have canneries at points in Alaska. The city has a population of about 5,000 during the winter, which is increased to 6,000 or more during the salmon season, at which time many fishermen and cannery employés come to this section from other regions.

Astoria has many peculiarities, among which is the fact that it is built on piling and extends out over the river; the steep hills that come down to the water's edge afford little opportunity for the erection

of dwellings, stores, etc., and it has therefore been necessary to construct the town in the manner mentioned. Another cause for building the city this way was that the river was shallow at this point, and it was necessary to extend the limits of the town some distance into the stream to get the requisite depth of water to enable ships to float while loading. In recent years some private residences have been built on the side of the hills back of the business portion of the town. There are few places in the world that are centers of greater activity than Astoria during the salmon season, but at other times it is comparatively quiet and uninteresting.

The Cascades is an unimportant settlement of a few hundred people, composed chiefly of persons engaged in building the locks around the Cascades. Some railroad men and a few fishermen make their homes at this point. It has some importance, from a fishery standpoint, as large consignments of fresh salmon are shipped from it.

The Dalles, a town of about 2,500 inhabitants, has a salmon cannery, which is the farthest one from the sea on the Columbia River. Like the Cascades, it is a point for the shipment of fresh salmon eastward; but beyond this it has no special importance in connection with the fisheries, though a large amount of wheel fishing is carried on in the vicinity.

Ilwaco, Washington, is a small settlement of a few hundred inhabitants, situated on Baker's Bay, in the center of the pound-net fishery. It is the southern terminus of the railroad line to Shoalwater Bay. Its inhabitants are engaged chiefly in fishing and in operating the lumber mills of the region. There is a cannery located at Ilwaco. A large percentage of the catch taken at Baker's Bay goes to other canneries on both sides of the river.

Importance of the fisheries.—The canning industry on the Columbia supports the most important river salmon fishery in the world. It has built up and still maintains many settlements, and gives employment to much capital and a large number of people. The annual product is measured only by millions of dollars, and it is doubtless safe to say that nowhere else on the globe has a like area of water produced such an immense yearly yield of wealth. There is little fishing except for salmon; sturgeon are taken to some extent, and a few fish of other varieties are caught to supply the local markets; a small amount of crayfish and clams is also secured and disposed of locally, but in this region the term "fishing" is generally applied only to the capture of salmon.

Species, seasons, etc.—Five species of salmon enter the Columbia River, but only three are sufficiently abundant or valuable to be commercially important there. One species of trout (*Salmo gairdneri*) is commonly, though erroneously, termed a salmon, its popular name being "steelhead salmon."*

* Many of those engaged in the salmon industry on the Columbia have fallen into a great error concerning the number of species of salmon in that stream. On account of a lack of knowledge of ichthyology certain individual differences in appearance

The chinook salmon (*O. chouicha*) is by far the most important species. It averages 22 pounds in weight and attains a maximum size of 65 pounds or more. Formerly it was the only kind used for canning, and even at the present time constitutes three-fourths of the pack. The growing scarcity of the species in recent years has, however, made it necessary to utilize other varieties of salmonidæ, and now more or less is packed of other kinds. This fish runs up the following tributaries of the Columbia: Cowlitz, Lewis, and Lake Rivers, in Washington, and the Willamette, Young's, and Lewis and Clark Rivers, in Oregon. It also enters many other streams. It is well known that it runs up the Clackamas, a branch of the Willamette, where the hatchery of the U. S. Fish Commission is located.

The blueback salmon (*O. nerka*) is in favor for packing, its flesh having a bright red color. Its average weight here is about 4½ pounds. It enters the river with the chinook.

Gardner's trout (*S. gairdneri*) averages 8 to 10 pounds. It is less highly prized for canning, because the flesh is light in color and the bones hard. It is a good market fish.

White salmon (*O. kisutch*) ordinarily weigh from 8 to 60 pounds; the average is about 20 pounds. The common name of this species is due to the light color of its flesh, a characteristic which decreases its market value notwithstanding its excellent flavor. The white salmon, according to Jordan, is identical on the Columbia with the silver salmon, or "silversides," as Wilcox heard it called. The "silversides" come only in fall; they constitute the last run of the season, but receive comparatively little attention.

The dog salmon and humpbacked salmon enter the Columbia, but the latter is so rarely seen there—coming only as an estray—that the term "lost salmon" has been applied to it. The dog salmon is not considered commercially important.

---

have been taken as a basis for claiming that many more species enter the Columbia than really exist. Wilcox was told that there were at least 12 species. In a report on the "Salmon Fisheries of the Columbia River" (Ex. Doc. No. 123, Fiftieth Congress, first session, page 16) W. A. Jones, major of engineers, U. S. A., has published, on the authority of Mr. G. W. Williams, a list of 12 names of salmon that "run in the Columbia River," as follows:

Chinook (*Salmo quinnat*).	Leather (not classified).	Weak-toothed (*Salmo paucidens*)
Blueback (not classified).	Silversides (*Salmo argyreus*).	Gairdneri (*Salmo gairdneri*).
Steelhead (*Salmo truncatus*).	Large white.	Hybrid (not classified).
White (*Salmo tsuppitch*).	Dog salmon (*Salmo canis*).	Humpback (*Salmo proteus*).

Professors Jordan and Gilbert, the well-known ichthyological authorities on west coast fishes, state that there are only "5 species of salmon (*Oncorhynchus*) in the waters of the North Pacific." The salmon, particularly the male fish, changes its appearance materially in the breeding season, and it is difficult for any but an ichthyological expert to determine the species correctly at such times.

Mr. Williams has apparently made 2 species of Gairdner's trout (which is not a salmon), for he calls it "Gairdneri," its specific name, and in another place classifies it as "steelhead," its common name. In the latter case a scientific name is applied which is not now recognized as properly belonging to the steelhead.

This matter is referred to in order to remove a quite common error.

Nearly all of the blueback salmon and the bulk of the chinook salmon enter the Columbia in the spring. Ordinarily the run of both begins about the last of March and continues until autumn, subject, however, to many interruptions and fluctuations from a variety of causes. As a rule the summer runs are light, but they increase when the autumn rains fill the rivers and send a volume of cold, fresh water out into the Pacific.

"Those salmon which run in the spring," remark Jordan and Gilbert, "are chiefly adults (supposed to be at least 3 years old)." A rise in the river during spring always brings in a large school of salmon, or "increases the run," as it is called. "As the season advances the smaller and younger salmon of these two species (quinnat and blueback) enter the rivers to spawn, and in the fall these young specimens are very numerous."

Mr. Livingston Stone has estimated the progress of salmon in the Columbia, after entering the river, at about 3 miles per day. At first they "play" about in the river without seemingly making any special effort to advance, though they always head toward the current. Later they gather in the deeper parts of the channel and swim up the stream.

The salmon season on the Columbia and its tributaries is limited by law. The "season" begins on April 1 and continues until August 1. There is a close season during August and September, but after this expires there is a limited fishery in the fall.

Trout and salmon trout are reported abundant in the tributaries of the Columbia near their headwaters. These may eventually become commercially important. At present they are seldom or never taken for commercial purposes, though many are caught by Indians and others living along the streams for home use, and occasionally some may find their way into the Portland fish markets.

Sturgeon of large size are abundant at least as high up as the Snake River. The maximum weight is 600 pounds,* though the fish ordinarily weigh from 40 to 200 pounds. The fishermen claim that there are three edible species of sturgeon (besides the green sturgeon, which is not eaten), but this is undoubtedly an error, for the best authorities mention only *A. transmontanus* in addition to the green variety. Flounders and soles are taken in considerable numbers near the river's mouth, but are not saved. Herring do not regularly enter the river. Smelt are abundant in February and March in the Columbia and several of its tributaries. Sardines are numerous from July to October. Suckers and "Oregon pike" are plentiful enough, but are not in demand except by Chinese. Shad weighing from 4 to 6 pounds enter the river in small numbers. A few are taken in pounds and wheels. Lamprey eels (*Ammocœtes tridentatus*) are very abundant, and are the only eels found in the river. They have a habit of crawling out on the rocks or ledges on the river banks at The Dalles, Cascades, and at Oregon City, on

* A sturgeon of this size is said to have recently been taken at The Dalles.

the Willamette, and, being indifferent to the approach of man, they are easily picked up. There is no regular fishing for them as for other species, though some are taken in the fish wheels with other kinds of fish. They are little esteemed commercially and comparatively few are saved. Those taken are sold for bait to the sturgeon trawlers, and a few are salted at Oregon City. Jordan states that this species of eel "reaches a length of 2 feet, and becomes very fat. It is never used as food so far as we know."* There are a few perch in the Columbia and tributaries. A few crayfish are taken. The razor clam is very abundant at Clatsop Beach, a few miles below Astoria, and is the object of a small fishery.

Fishing grounds.—So far as commercial fishing is concerned, the fishing grounds extend from the mouth of the river to Celilo (about 15 miles above The Dalles), a distance of about 200 miles. Salmon run up several of the tributaries of the Columbia, which have already been mentioned; but, with the exception of the Willamette and the Clackamas, none of these streams can be considered fishing grounds from a commercial standpoint. The great bulk of the fishing is in the lower part of the Columbia, within 35 to 45 miles of its mouth, and the relative importance of this stretch of fishing ground is governed by its nearness to the ocean, the section below Astoria being the most productive.

Baker's Bay, on the north side and just within the river's mouth, is the favorite ground for pound-net fishing. In 1889 there were 121 pound nets operated there. A few pound nets are set in Young's Bay, opposite Baker's Bay, just below Astoria; some are scattered along the river's banks and on the bars for about 5 miles above Astoria.

The great fishing ground for drift gill nets is from the river's mouth to about 15 miles above Astoria, but drift-net fishing is prosecuted in the channel for a considerable distance farther up the river. Set gill nets are chiefly used just below the Cascades.

The fishing ground for drag seines covers about the same part of the river as that resorted to for drift gill-net fishing, though, with the exception of one hauling reach on Sand Island, in Baker's Bay, all the seine grounds are on the bars and shallow shores above Astoria, and mostly within about 15 miles of that city. A few reaches are worked, however, as high up as Fish Trap Shoal, about 60 or 70 miles above Astoria. Not many years ago these seine reaches, which are simply sand-bars that are under water at high tide, were purchased from the State for merely nominal sums—only a few dollars. Many of them are now very valuable, some being worth upwards of $1,000 each.

The grounds upon which slat weirs are operated begin about 15 miles above Astoria and continue to the lower end of Sanvies Island, some 45 or 50 miles farther up the river. These are usually set from the banks of the river or the shores of the islands bordering the channels. In some places they are numerous, but are generally very much scattered.

*Proc. U. S. Nat. Mus., vol. 4, p. 30.

At the Cascades, The Dalles, and Celilo are the fish-wheel and dip-net fishing grounds.

Wilcox states that from Rainier, 46 miles below Portland, to Oneonta fishing is prosecuted chiefly to supply the market. Here drift and set gill nets of small size are employed; the boats are not so large as those of the lower river, and the fishery is not of extensive proportions.

The Willamette, below Portland, is frequently resorted to by the fishermen on the Columbia, and is embraced in this report.

The number and location of pound nets, slat weirs, and wheels are shown on the maps, plates XXXI and XXXII, on which also are defined the seine-reaches, gill-net grounds, etc.

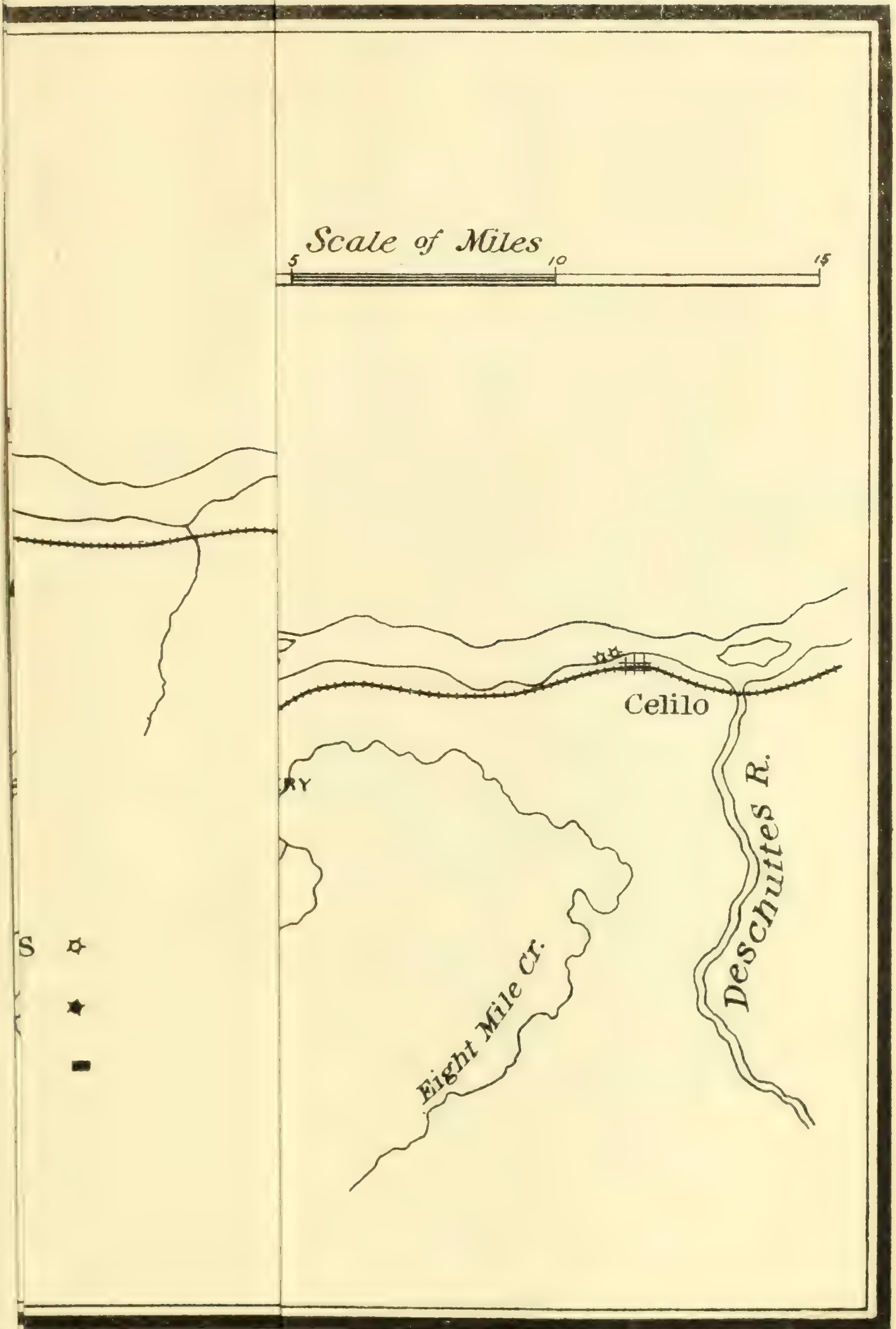
Fishermen, factory hands, lay, etc.—The fishermen on the Columbia River are natives of many countries. In addition to native-born white Americans and Indians, no less than twelve other nationalities are represented, of which all except the Chinese are Europeans. Natives of northern Europe are most numerous, Sweden, Norway, and Russia being largely represented. There are, too, many native-born Americans—20 per cent. of the whole—while 50 Indians engaged in fishing in 1888.* It is a noticeable fact, however, that notwithstanding the great predominance of Chinese in the canneries, very few of them engage in catching fish. Those who are classed as fishermen are simply helpers in capacities where they seldom catch the fish themselves, but fill places where they do not come into competition with other fishermen. Most of them, if not all, are employed in connection with the fish wheels. As a rule, fishermen of other races are inimical to the Orientals, and the latter seldom find it practicable to overcome this prejudice sufficiently to make it possible to peacefully follow fishing.

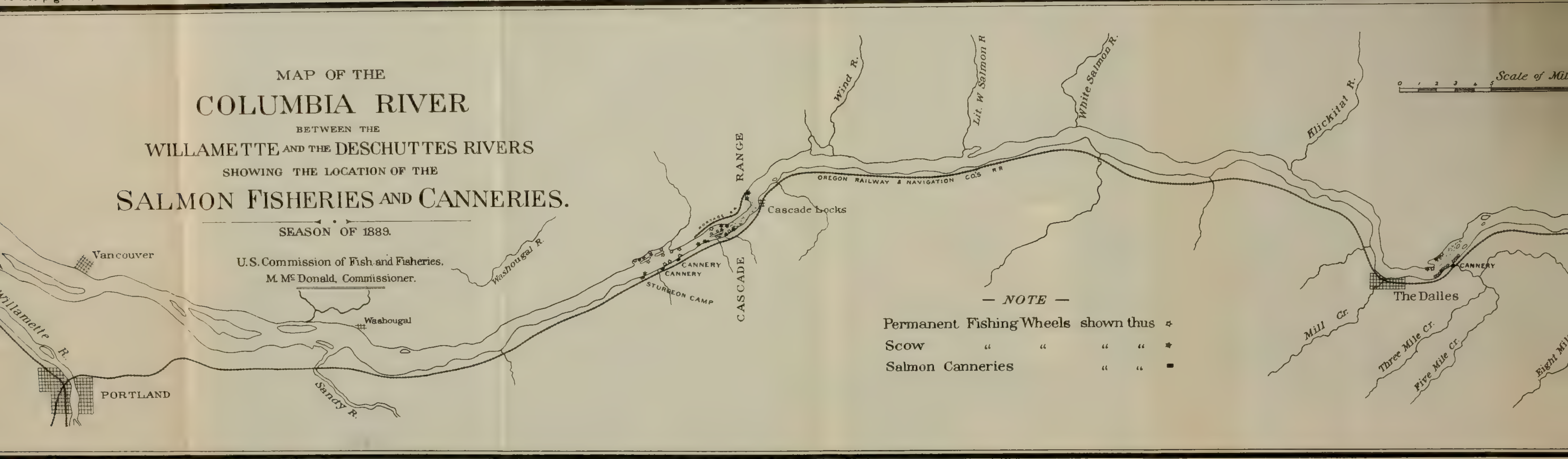
The tendency among the foreign-born fishermen to become citizens of the United States is more marked here than elsewhere on the Pacific coast. Thus, we find that whereas only 21 per cent. of the fishermen (including Indians) are native-born Americans, no less than 71 per cent. owe allegiance to the United States. Reference is made to the statistical statements relating to the fishermen for details. Wilcox found that about one-third of the fishermen on the Columbia and its tributaries are non-residents, who come here only to participate in the salmon fishery, and leave as soon as the season closes to engage in fishing elsewhere or to work upon farms, etc. About 900 live at Astoria, and many of them have families; others are scattered along both banks of the river, but chiefly on the Oregon side.

On April 11, 1886, the gill-net fishermen organized as an association under the name of "The Columbia River Fisherman's Protective Union," and secured the incorporation of the society on August 16 of the same year. The organization of this union was the outcome of a strike

* A great many Indians fish for themselves on the upper river, but not in a commercial way. These have not been included, nor was it practicable to get any estimate of the fish taken by them.

PLATE XXXII.




MAP OF THE
COLUMBIA RIVER
BETWEEN THE
WILLAMETTE AND THE DESCHUTTES RIVERS
SHOWING THE LOCATION OF THE
SALMON FISHERIES AND CANNERIES.
SEASON OF 1889.
U.S. Commission of Fish and Fisheries.
M. McDonald, Commissioner.
Vancouver
Willamette R.
PORTLAND
Washougal
Washougal R.
Sandy R.
CANNERY
CANNERY
STURGEON CAMP
CASCADE
RANGE
Cascade Locks
Wind R.
Lit. W Salmon R
White Salmon R.
OREGON RAILWAY & NAVIGATION CO'S RR
Klickitat R.
Scale of Mil
0 1 2 3 4 5
— NOTE —
Permanent Fishing Wheels shown thus
Scow " " " "
Salmon Canneries " "
Mill Cr.
The Dalles
CANNERY
Three Mile Cr.
Five Mile Cr.
Eight Mil

against the canneries, which offered the fishermen 55 cents per salmon for the season. The strike continued until the middle of May (at an estimated loss to the business of $500,000), when the canners acceded to the demands of the fishermen by paying 65 cents per fish. In 1889 the union had a membership of about 2,500, which included all the drift gill-net fishermen on the river. The headquarters are at Astoria, where the union has a large reading room on the main street of the city. Here the fishermen have collected a considerable number of books bearing upon their work; the leading periodicals and the daily papers are also available to them. This is the meeting place of the union, and here such business as comes before it is transacted. Some officer of the organization, usually the secretary, is continuously on duty at the headquarters, where the fishermen assemble in the evening to read the news, or converse, or to amuse themselves by playing games.

It is intended that the organization shall be composed only of gill-net fishermen of the Columbia River and its tributaries, and that no one shall be admitted to membership whose influence may in any manner conflict with the interests of the union. The following, extracted from the constitution, shows the limitations of membership:

> No liquor dealer, gambler, politician, capitalist, lawyer, agent of or for capitalists, nor persons holding office, whether under the national, State or municipal government, shall under any consideration become members of this organization, but all such shall be strictly excluded from membership in this union. No stockholder or shareholder of any cannery is eligible to membership in this union. Protection to members shall only apply to the Columbia River and its tributaries.

The union is decidedly opposed to methods of fishing other than with gill nets, and is specially antagonistic to pound nets and wheels. It therefore naturally does not affiliate with those who operate such forms of apparatus. The dues are $4 per annum, or $1 per month for the fishing season. There are no benefits, except that a sum of $50 is appropriated for the burial of deceased members of good standing.

The union fixes the prices of gill-net salmon at the beginning of the season. This is not changed without consulting the union, and the canners must pay the rate decided upon or stop operations, since they have no other recourse and no voice in the matter.* Indeed, no gill-net fishermen except a member of the union can sell salmon at the canneries, since a canner who bought of others would be liable to have his supply of fish cut off. The employment of a non-union man on the boats is strictly prohibited. Not only does the union determine the price of salmon, but it arranges the lay of the fishermen, both as concerns the

---

* The price fixed upon relates to salmon above a certain size, which is usually 24 pounds. Those of less weight count as two for one, or else they are weighed and the average of the standard size is taken for determining the number. Bluebacks and steelheads are usually sold by the pound, the price for the former being 5 cents per pound in 1888, and the latter selling for 3 cents. Sometimes three or four fish count as one salmon.

relations between capitalists and fishermen and those between the men themselves.

The crew of a gill-net boat consists of two men, one designated as the "captain," and the other (who always rows the boat when the nets are being shot) called the "boat-puller" or "helper." In most cases the boats are owned by the canneries, while the nets are the property of the fishermen,* but in some cases the latter have an interest in or may be the sole owners of both nets and boats. The arrangement is such that the "boat-puller" receives one-third of the money obtained for the fish at a fixed rate, while two-thirds of the proceeds go to the captain, net, and boat. Theoretically, the boat and apparatus take one share, and the other two shares are equally divided between the men.†

The terms upon which boats are obtained of the canneries varies with the exigencies of the business. In 1888 the fishermen paid from $40 to $50 for the rent of each gill-net boat, but the next spring these were furnished free of charge, and fishermen who had boats of their own received $40 extra from the canners.

During the fishing season the fishermen live a good deal on board their boats. After the nets are hauled and the catch disposed of, the boats are often run into some cove or bay, where they are brought to anchor. The fishermen in each boat then unship the rudder and set it up amidships to support one end of the gaff, the other end of which rests upon the bow. The sail is thrown over the gaff, like an awning, and this constitutes the roof to an improvised cabin or cuddy, under which the crew sleep. Coffee or tea is made over a lamp, and when the meal has been eaten the men crawl under the sail and sleep until the tide is favorable for fishing. It is not uncommon to see hundreds of boats anchored in this manner along the coves or bends in the river, out of the way of passing steamers. Absolute quiet reigns, and one who for the first time sees such a fleet, literally sleeping upon the river, is little prepared for the scene of busy activity presented when it wakes with the turning tide, and the broad bosom of the great river is almost instantly covered with boats putting out from all directions.

In many cases fishermen land the salmon at canneries near their homes, and then go home to sleep until the hour for fishing.

The fishermen who operate the pound nets, slat weirs, seines, and

---

* Formerly the nets, as well as boats, were usually the property of the canneries, and these were rented to the fishermen, the canner receiving one-third of the catch for rent. But about 1888 this system was discontinued, and now the fishermen have to buy their own nets, though, as stated above, the boats are still rented, as a rule. It was believed by the capitalists that this would induce the fishermen to take better care of the nets than they otherwise would. A common saying on the Columbia is that a fisherman who is using his own net rarely "catches a steamboat in it," a phrase due to the fact that formerly, when the nets were owned by the canneries, the gear was often destroyed by passing steamboats, because the men did not exercise the necessary care to avoid such mishaps.

† The "boat-puller" is paid, according to Wilcox, on the basis of 35 to 40 cents for each salmon taken, or considerably less than the price paid by the canners.

wheels, and those who engage in dip-net fishing, carry on their work to some extent upon different terms from those which govern the gill net fishermen, though the practice of fixing the price at so much per fish seems to be the system in most general favor amongst all the canneries and fishermen. In the case of the wheels, however, there are no fishermen, strictly speaking, since the apparatus is automatic and "pumps the fish out of the river." Men are employed simply to look after the wheels and attend to the catch.

The minimum size for "count" salmon caught in pound nets and slat weirs would appear to be 14 pounds, according to the testimony given before the Senate Committee on Relations with Canada (page 243, Report 1530, Fifty-first Congress). This is undoubtedly incorrect, and the error is perhaps due to a misprint. A "standard salmon" is a chinook, and Wilcox learned that, while there may be some variation at the different canneries, the generally recognized standard of weight was 24 pounds; of course a fish that weighs more, even as high as 60 pounds, counts only as one salmon. Both fishermen and cannery agents become so expert in judging of the size of salmon that the weighing is almost wholly "by the eye"; scales are seldom used to determine the weight, except in a few instances where the contract calls for the fish to be weighed and averaged.

Eighty-eight per cent. of the people at the canneries are Chinese. Of the remainder, 34 are natives of various European countries and 152 (including 15 women) were born in the United States. The whites are generally clerks, overseers, etc. Those who are interested in canning state that it would be difficult, if not impracticable, to supply the place of the Chinese in the canneries with white men who would be reliable and industrious and, at the same time, willing to work for only 4 months of each year.* The majority of the Chinese "help" return to the canneries season after season, and it has been stated that "a good Chinaman will make from $180 to $200 in a season." They labor largely on the piecework system, and this has proved satisfactory to employers and employés.

Many of the Chinese work for $1 per day of 11 hours, "and work as wanted, *i. e.*, leaving when told and coming at any hour set, only the time in which they are actually engaged being counted."† Some of the most capable receive $40 to $50 per month. The following condition at one cannery will, perhaps, give a good idea of the relative wages: This establishment had about 125 men; 30 were white men, of whom 10 were tinners and received $52.50 each per month; two boilers were paid from $3.50 to $4.50 per day, and the others (18) got $1 per day; 20 Chinese tinners were paid $50 per month; Chinese cleaners, $25 per month; fillers, $30 per month, and the remainder $1 per day when working.

---

*See "Testimony taken by the Select Committee on Relations with Canada," United States Senate, Report 1530, Fifty-first Congress, first session.

†Jordan and Gilbert.

The white help in the canneries is generally hired by the month, the wages being graded according to efficiency and responsibility.

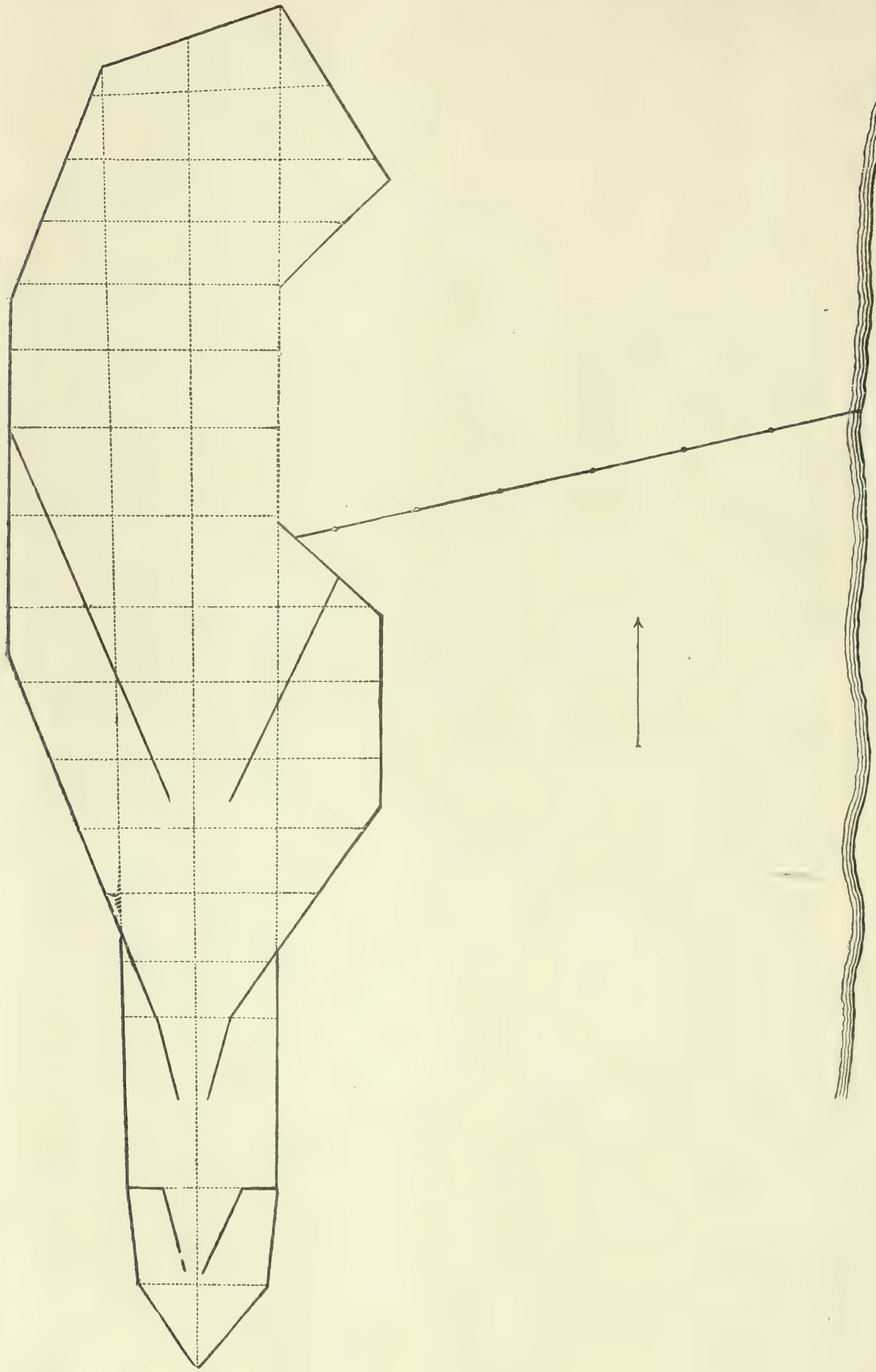
Close season.—It is unlawful to fish for salmon in Oregon during March, August, and September. In Washington fishing is not permitted in March and September. Both States prohibit fishing from 6 p. m. Saturday to the same hour Sunday during each week of the "season." These restrictions are applicable only to the Columbia; they do not apply to the small coast rivers. Although fishing is permitted on the Washington side of the river in August, little or nothing is done during that month. There seems to be a tacit understanding between the packers that it is best for all that the "season" should not continue beyond the limits fixed by Oregon. The law is generally observed by the fishermen. Occasionally one is arrested, but convictions are rare. The penalty for illegal fishing is not less than $500 nor more than $1,000 for the first offense; for subsequent offenses the court may add imprisonment, at its discretion, the term not to exceed one year.

Vessels and boats.—Several small screw steamers of the tugboat pattern, a few steam-launches, and some sailing craft are employed in connection with the canneries, chiefly in transporting freshly caught fish from the fishing stations or grounds to the packing establishments. In 1888 there were employed as tenders 10 steam-tugs, with an aggregate tonnage of 192.04; 2 steam-launches, too small to be documented, but each about 4 tons measurement; a sailing schooner of 7.43 tons; a sloop of 10.43 tons; and a sloop-rigged boat of about 4 tons; these had an aggregate value of $62,450. They were manned by 50 men, nearly all Americans by birth.

In 1889 the steamer *City of Astoria* was built and added to the fleet, and the steamer *Fisher* (formerly the *Frolic*), which had been idle during the previous season, was employed as a tender. The former was 29.64 tons and the latter 32.09 tons. Thus two steamers, with an aggregate tonnage of 61.73 tons, a total value of about $15,000, and crews averaging 4 men each, were added to the fleet of tenders in 1889.

The boats employed in fishing are almost wholly of two types, viz, the gill-net boat and the seine boat.

In the Columbia River fisheries it is common to have square-ended flat-bottomed scows moored at certain favorable points near the fishing grounds. These scows are housed over and are utilized as receiving depots for the canneries. They are about 30 feet long and 12 to 15 feet wide. A cannery agent is on board each scow to receive, count, and record the catch when the fish are brought in. The salmon are thrown on board the scow, each boat or pound net is credited with its "tally" on a pass book carried by the fishermen, and at the proper time the tender comes along and the fish are soon transported to the cannery. The tugs visit both scows and boats and pick up all the fish they can get. As the salmon move up the river and the fishing ground changes



SLAT WEIR FOR TAKING SALMON IN THE COLUMBIA RIVER.

the scows can be correspondingly moved to suit the convenience of the fishermen. They are used chiefly in Baker's Bay.

In the seine fishery both men and horses live on large scows when not employed in operating the nets. These scows are housed over. In some cases the horses are quartered in one end of the scow and the men in the other, but quite as frequently there are two scows to a seine gang, one for the fishermen and the other for the horses.

Apparatus.—The only really important forms of apparatus employed on the Columbia are those used in the salmon fishery. These are (1) movable gear, such as gill nets, seines, "squaw nets," and dip nets; and (2) fixed apparatus, which includes pound nets, slat weirs (or traps), and fish wheels.

Gill nets are of two kinds, called "drift nets" and "set nets," these names having special reference to the manner of using them. The gill net is the oldest and most popular form of apparatus used in the salmon fishery. In 1887 it is stated that 1,600 nets were employed in the drift fishery of the lower Columbia. The nets used in this fishery range in length from 250 to 300 fathoms or more, but are mostly about 300 fathoms. They are 45 meshes deep (25 to 30 feet), the mesh being generally 8½ to 9 inches. The minimum legal size is 8½ inches, and occasionally a 10-inch mesh is used.

The nets are all handmade by the fishermen themselves or their families; the fishermen's union prohibits the use by any of its members of factory or Chinese-made nets. Fine flax or linen twine is used; this is the celebrated "Barbour twine;" it has 12 threads and is laid slack. Hard-laid twine would not "fish well." The nets are made "between seasons" and are hung ready for use in the following spring. They are hung in the ordinary manner—to a cork rope, with floats to support the upper edge of the gear, and to a lead line with sinkers attached which keeps the net vertical in the water and all its meshes properly distended. After being hung the nets are tanned, and it is said they are tanned twice a month during the fishing season. The cost is about $300, or $1 per fathom. Nets ordinarily last about two years, but the fishermen generally expect to put in half new twine each season.

The set nets are not used in the lower part of the river, but are employed chiefly on the Willamette and near the Cascades. They are mostly machine-made; vary from 25 to 100 fathoms in length, from 35 to 50 meshes in depth, and the mesh ranges from 5 to 10 inches. Their cost is proportionately smaller than the drift nets, but will not vary materially from $1 per fathom of length.

A few reels for drying gill nets are used on the Columbia River similar to those of the Great Lakes, but generally these are not in favor. Nets are most commonly dried on shore by spreading on frames on the wharves, and occasionally they are hoisted on the masts of the fishing boats. The drying of nets precedes mending, but nets are dried after being tanned or retanned, and always after being taken from the water.

The seines are all of the type ordinarily called haul seines or drag seines, and have certain peculiarities made necessary by the fishery in which they are used. These seines are factory-made and cost from $500 to $600 each. The length of the seines varies from 200 to 300 fathoms; the shallowest end is from 35 to 40 meshes deep, but it gradually increases in width and is from 120 to 140 meshes deep at the other wing. The "bunt" or central part of the net is about 50 fathoms long, and this section has a mesh of 4½ to 5 inches; the size of the mesh in the wings is 6 inches. The outfit of a seining gang includes, in addition to the seine itself, boats, warps, horses, scows for the men and horses to live upon, etc., the whole reaching an aggregate of $1,500 to $1,800.

The large dip nets used for catching salmon at The Dalles and Cascades are similar to the nets employed for dipping mackerel, herring, and menhaden from seines, weirs, and pounds on the Atlantic coast. An iron hoop, about 2½ feet in diameter, is secured to the end of a stout pole some 18 to 20 feet long, and to the hoop is fastened a bag-shaped net 3 feet deep, with a 3-inch mesh. A net of this kind, with accessories, such as platforms, etc., costs about $20.* Rude wooden platforms are built out from the shore over the rapids, and on these are boxes to receive the fish. The fishermen stand upon these to operate the dip nets, and therefore the platforms may appropriately be considered a part of the apparatus.

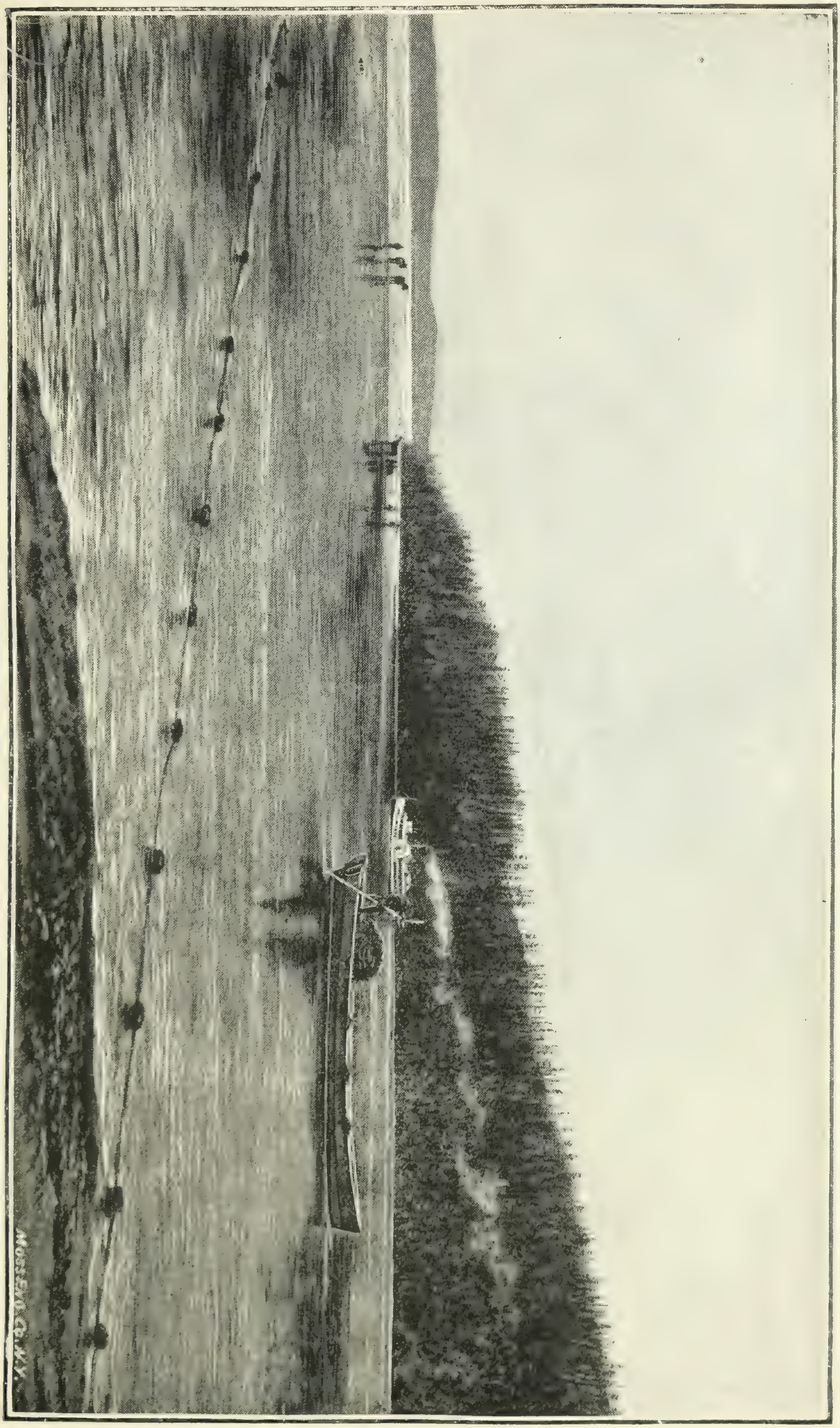
The "squaw net" is used by a few of the dip-net fishermen. It derives its name from the fact that it is the same net commonly used by Indian squaws for taking salmon. It consists of an oblong sheet of gill net about 12 feet long and 8 feet deep, its lower edge weighted to keep it down, and its upper edge attached to a pole that floats at the surface, and which is held by a line or lines to another projecting pole that is securely fastened to the shore so that it will not swing around with the strain of the swift current upon the net. The mesh is the same as that of the set nets. A single block is attached to the pole, and through this passes a rope, thus making a tackle for the more convenient manipulation of the net.

Pound nets were introduced on the Columbia River in 1879. In May of that year Mr. O. P. Graham, formerly of Green Bay, Wisconsin, built a pound net on the river similar to those used on the Great Lakes. The success of this venture led to the employment of more apparatus of this kind, and many lake fishermen went West to participate in the fishery. In 1888 105 pound nets were operated, and this number was increased to 154 the next season.

The pound net of the Columbia River is the same as that used on the Great Lakes. It consists of a leader of varying length, but usually from 400 to 600 feet long, and a harpoon-shaped heart terminating in a

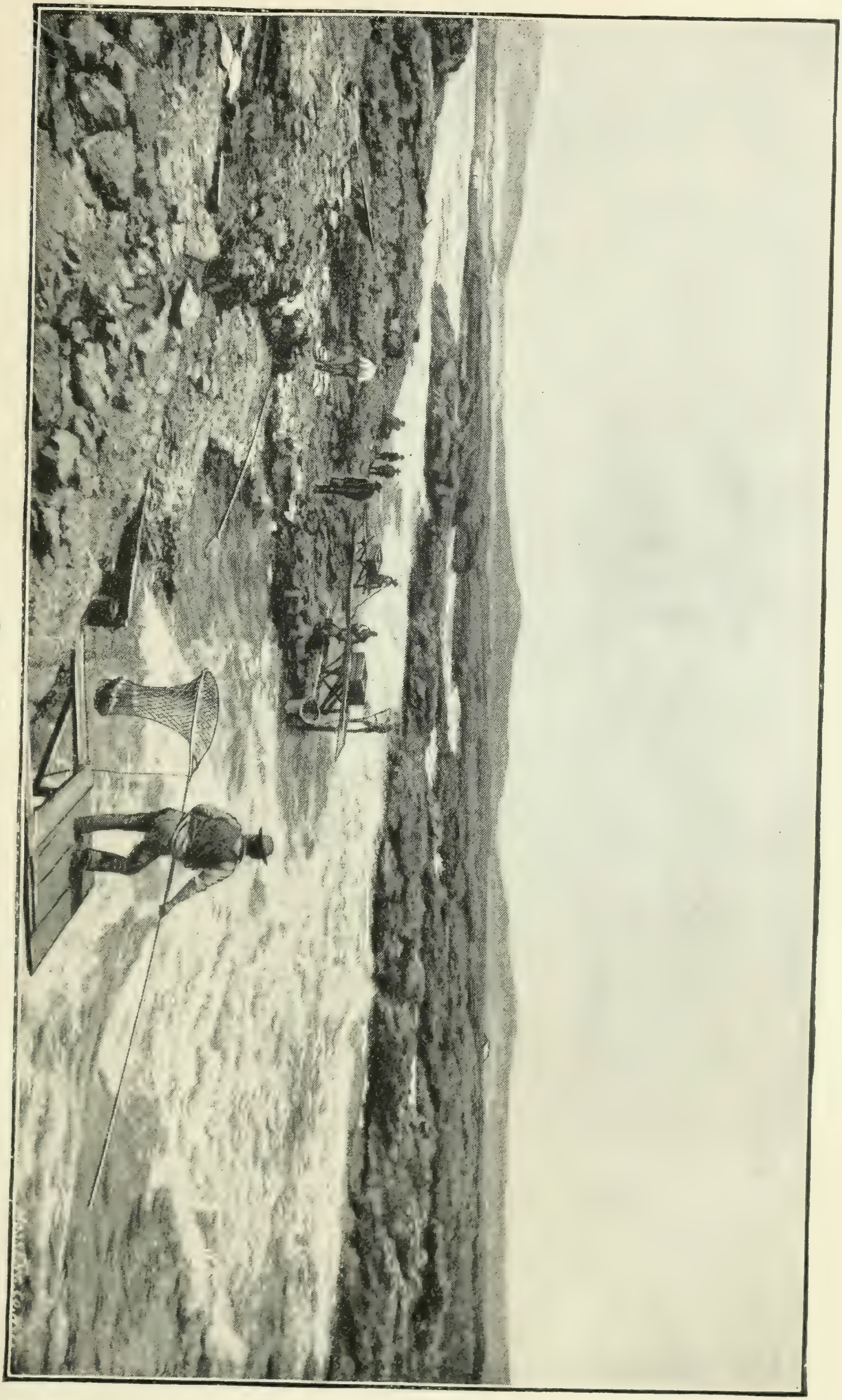
* The valuation is intended to be an average which will cover the squaw nets that are used by the dip-net fishermen, and for this reason no separate figures are given for squaw nets in the statistical tables.

PLATE XXXIV.



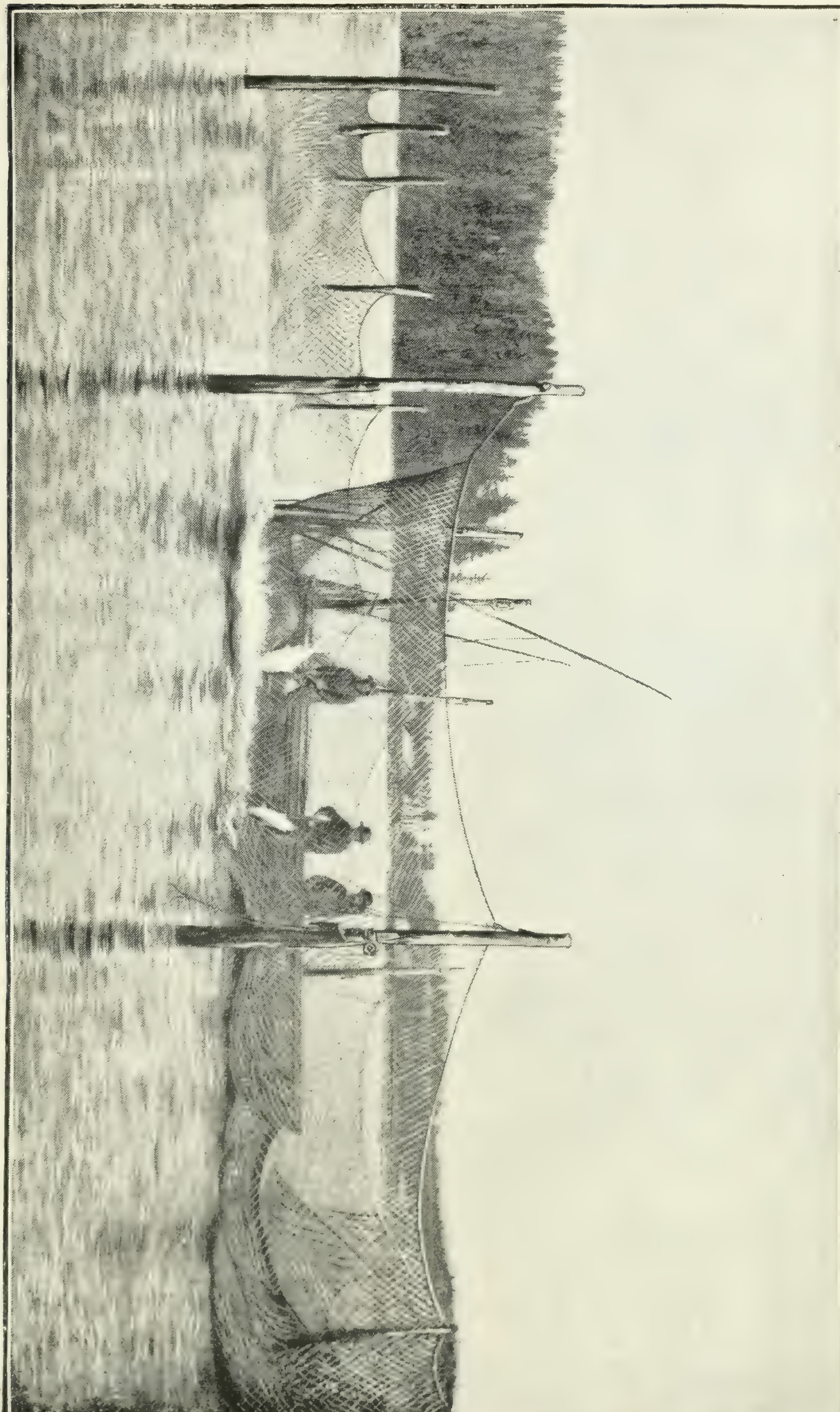
SEINE FISHING.

PLATE XXXV.



DIP-NET FISHING.

PLATE XXXVI.



POUND-NET FISHING.

funnel through which the fish enter the square crib or pound. The leader, which runs out from the shore or shoal, is made of twine or of galvanized wire netting, stretched upon poles or piles that are driven into the bottom. The use of wire for pound-net leaders is comparatively recent. In fresh water it lasts several years, and is a good substitute for twine netting, but in salt water it can not be used more than one season, consequently it is being discarded by the fishermen on the lower river. The wire netting, in sheets 5 feet wide, costs 11 cents per running foot; when 3 feet wide the price is 8 cents per foot. Only about 12 per cent. of the pound nets have wire leaders. The heart and crib are constructed of twine netting stretched on poles, and the bowl is so arranged that it can be "lifted" for the purpose of removing the fish. During the weekly close season (Saturday evening to Sunday evening) the funnel through which fish enter the crib is lifted so that the pound can not catch anything. The size of the mesh is as follows: Leader, 6 inches; heart, 5 inches; crib or bowl, 4 inches. The cost of a pound net varies from $700 to $1,000.

The so-called wooden "traps" are essentially weirs, and are a modification of the brush weirs or traps used by the Indians for the capture of salmon long before the advent of white men.

The wooden weirs have been employed in the Columbia salmon fishery for 20 years or more, and their use dates back nearly to the beginning of the industry. They are built on shore, of piling and planks, the latter arranged like slats with spaces between. The general features of the construction, form, etc., are shown in the plan, plate XXXIII. The apparatus consists of a leader, generally from 200 to 600 feet long, two arrow-shaped hearts, with funnels that lead into the crib or box where the fish ultimately find their way. The weir is arranged to intercept the fish on their passage up the river; it therefore has an entrance on only one side of the leader—the down-river side. The instinct of salmon to go up stream is so strong that as soon as they enter the trap they immediately turn their head up the river and therefore are all the easier led into the upper section of the weir, from which there is no escape. The bowl is, however, provided with a movable trapdoor that can be opened during the close season, and on Sundays, so that the fish can pass through and run up stream. These weirs, after being built, are launched into the river, placed in proper position, and then ballasted so that they sink to the bottom. They are always located near the shore, and often they can not be fished when the water in the river gets unusually low.

Fish wheels are of two kinds, the floating or scow wheel that can be moved about from point to point, if need be, and the shore wheel, which is permanent. In either case the principle is the same. The so-called scow wheel may be thus described: The float consists of a large square-ended typical scow that is usually decked at one end and open at the other. Several stanchions, some 8 to 10 feet high, support a framework

upon which an awning is spread to protect the fish from the sun's rays and the crew from rain, etc. To one end of the scow are fastened two upright posts, which are guyed by wooden supports, while projecting from the same end is the framework that supports the wheel. The wheel itself is composed of three large scoop-shaped dip nets made of galvanized-iron wire netting, with a mesh of 3½ to 4 inches. These nets are the buckets of the wheel, and they are so arranged on a horizontal axis that when the scow is moored with this end down stream the wheel is kept in constant motion by the current, and thus picks up any fish swimming up the river which come within its deadly circle. The nets are fixed at such an angle that, as they revolve, their contents fall into a box chute through which the fish slide into the scow.

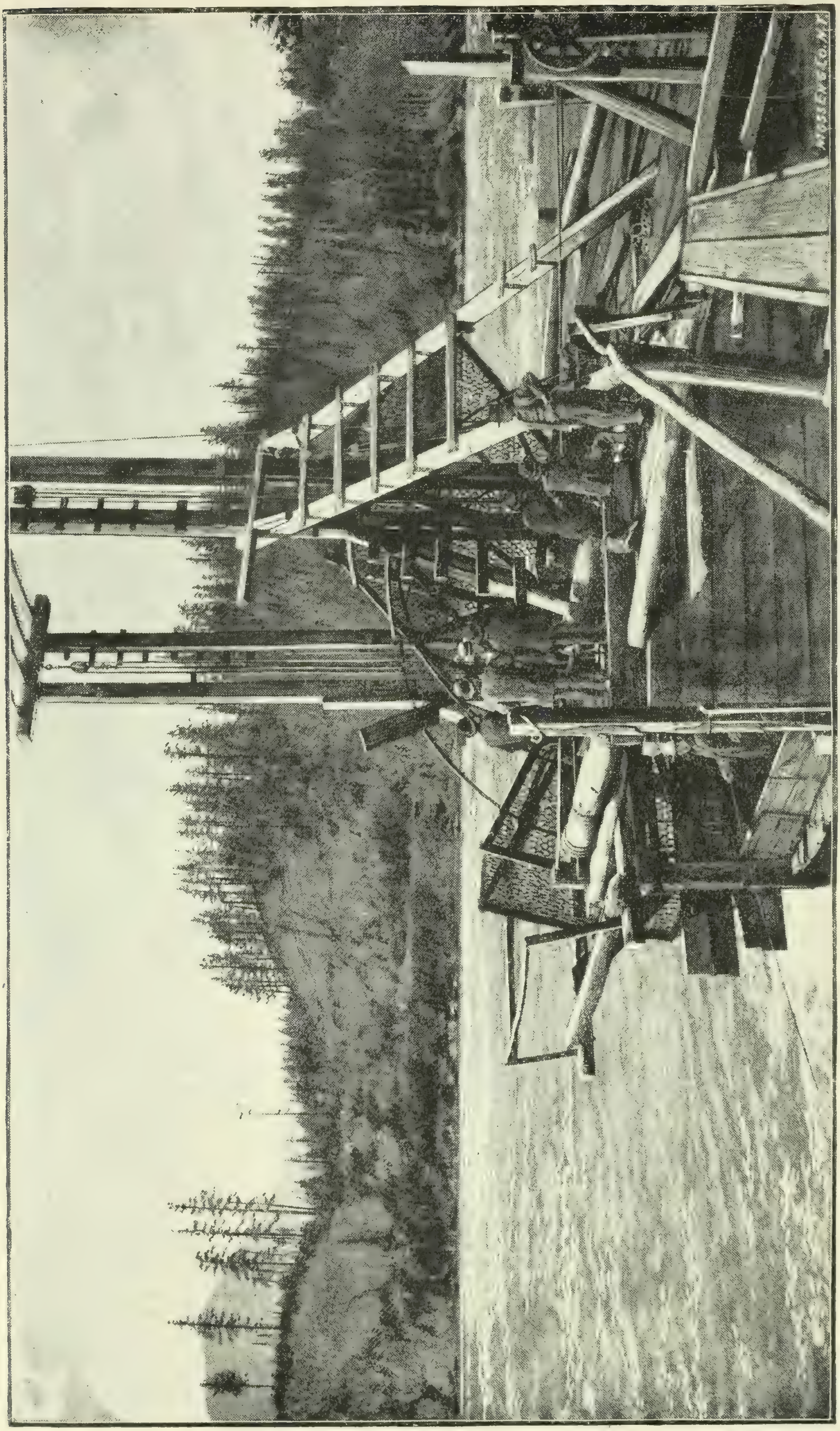
A scow usually has a mast at the end opposite to that upon which the wheel is placed, and on deck are such mechanical contrivances as experience has shown to be necessary for raising and lowering the wheel. During the close time the wheels must be raised above the water, so that they will catch no fish.

The fixed wheel is located in the most favorable position, where it is known the salmon have a sort of trail. Here an abutment is built of wood and stone, high enough to protect it from an ordinary rise in the river. To this is attached the necessary framework and the wheel, the latter being generally so placed that the full force of the current will come to it. The fish are carried through a chute into a large bin on shore, where the salmon are prepared for transmission to the canneries. The efficiency of the wheels is generally increased by building leaders in the river, so that the course of the migrating salmon will be directed more certainly to the point where their capture can be effected.

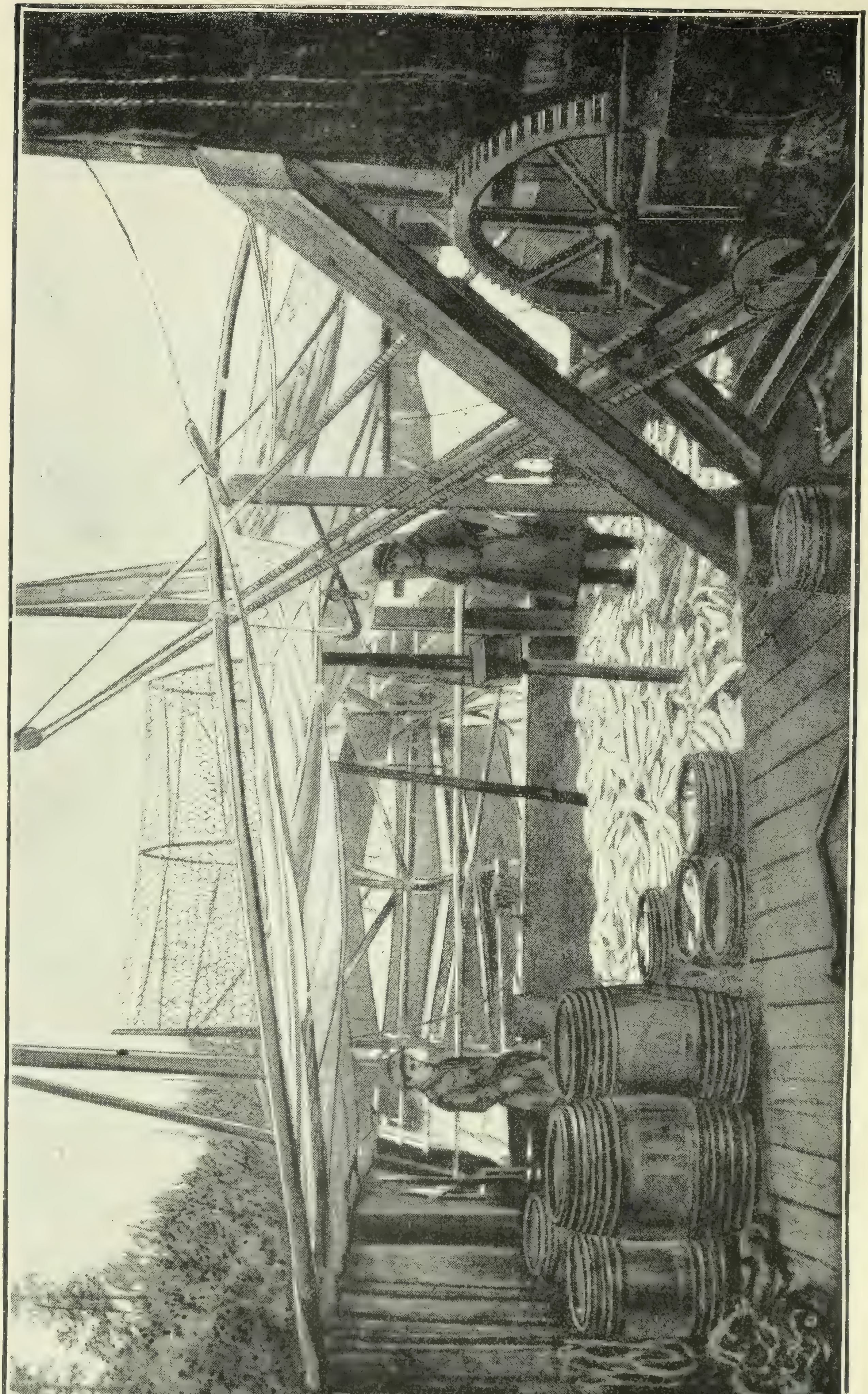
The success of the permanent wheels is frequently materially affected by low water in the river, and they are often stopped entirely from this cause. In the season of 1889 the river was unusually low, at least as late as June, and Wilcox reported that "not half of the wheels have been able to do any work." There is much variation in the size of fish wheels and a corresponding difference in their cost. The wheels range from 9 to 31 feet in diameter and from 4½ to 14 feet in width; they cost from $1,500 to $8,000. They do not often exceed $4,000 or $5,000; the most costly ones have long leaders of piling that materially add to the expense of construction.

Major Jones makes the following interesting allusion to the fish wheel and its effectiveness:

> The wheel is the apotheosis of the dip net. Imagine a white man of inventive mind standing on one of those bold rocks wearily pushing a dip net through the foaming torrent at his feet. His first thought would be a desire to have a net that would be in the water all the time, so that no fish should be able to get by. If he could handle a succession of four or five nets the thing would be accomplished. To place them on the periphery of a wheel with a horizontal axis, the wheel to carry paddles to make the current of water revolve it, would almost be a logical sequence of the thought. Elaborate the idea with some details of making the nets as wide at the mouth as



STATIONARY FISH WHEEL IN OPERATION.



SCOW FISH WHEEL IN OPERATION.

possible, and extending the bottoms inward to connect with inclined troughs placed along the axis of the wheel, so that when it revolved, gradually increasing the angle of the bottom of the net with the horizontal, the fish would gravitate towards the trough and slide out into a box placed below the shore end of the axis of the wheel, and we have a device for catching fish with a dip net that would appear simply divine in the eyes of the untutored savages who wielded it so long under the conditions of this locality.

The success of this fishing machine depends on the fact that there are many points along the rapids of the river where the trails of the traveling salmon come together alongside of rocky points projecting from the shore. A wheel placed so as to cover such a trail will be tolerably certain to catch the majority of the passing fish. There are only a few points where these conditions are maintained constantly during the varying stages of the river, and where wheels may permanently be placed, and hence some wheels are placed on the ends of scows, which can be moved from point to point to meet the varying conditions of river stage. The success of the fish wheels is painful. It has been aptly remarked that they pump the fish out of a river. And yet, if it be true that nearly all of the fish die after spawning, I can see no objection whatever to their use, provided they be required to stop fishing for two days, say Saturday and Sunday of each week, and that at the same time at least one hatchery be established on the upper waters of the river.

It has been demonstrated that a hatchery can insure the placing of enormous numbers of young fish in the sea annually, and the evidence of Mr. G. W. Williams shows conclusively that the place for propagating the chinook salmon is at their spawning grounds on Snake River. The wheel at the Cascades of the Columbia River, owned by Mr. Williams, catches more fish than any other. The maximum catch reported was 50,000 pounds in one day. At the time I visited the locality it was catching at the rate of 20,000 pounds per day. These wheels can only operate at certain stages of the river. At the Cascades they can not operate when the water is less than 15 feet above low water, nor when it is more than 47½ feet above.

While at the Cascades and The Dalles it was stated to me that 90 per cent. of the fish caught at these points were bluebacks and steelheads, and the catch during my visit verified the statement. This shows that about nine-tenths of the large chinook salmon are taken by the nets in and about the mouth of the Columbia River. Unless something be done to allow a larger percentage than this to pass up the river it will hardly be possible to get enough of this variety on the upper waters for propagation.

The fish wheel is a patented device. It was first used by the patentees, Messrs. G. W. Williams & Brother, in 1879, and for three years those gentlemen had a monopoly of the fishery with this form of apparatus. About 1882–83 other parties built fish wheels, and fishing in this manner has rapidly increased since that time. In 1889 there were 27 stationary wheels and 18 scow wheels on the Columbia, from the vicinity of the Cascades to Celilo. Reference is made to the map (plate XXXII) for the location of these.

Trawl lines are used to a limited extent for the capture of sturgeon. Some of these are of the Chinese pattern, fitted with barbless hooks placed 15 inches apart, with 100 hooks to each trawl. Others are rigged with ordinary American-made barbed hooks, upon which bait is used.

Methods of fishing, catch, etc.—Gill net drift fishing is prosecuted chiefly in the estuary of the Columbia in and near the channel. If the water is clear, the nets are set only at night; but a rise in the river, which is favorable for the salmon to "run," makes the water muddy, and at such times fishing is carried on both day and night. Night fish-

ing is most common and is preferred for several reasons. It supplies the canneries with fish early in the day, and it is thought that salmon landed then are in better order than those taken by day, when the temperature is usually higher.

In gill-net fishing on rivers it is necessary to work in a straight reach of water of fairly uniform depth and free from snags or sharp ledges. It has been aptly said that "a man can't turn a corner with a gill net." So a clear reach is selected, and this is called a "drift." In a river like the Columbia there are likely to be many drifts, and to each a special name is applied, such as "Brown's Reach," "Jones's Drift," etc. In setting the net the boat-puller rows slowly across the stream while the captain pays out the apparatus, to the first end of which a buoy and lantern have been attached. When about two thirds of the gear is out the boat is turned downstream nearly at right angles to her former course, so that the net, when set, approximates the shape of the letter L.

The foregoing is given on the authority of the Alta California, in its issue of April 20, 1884, which also had the following additional allusion to gill-net fishing:

The position of the net in the water is peculiar. The lead line is dragging on the bottom of the river, the cork line, impelled forward by the current, keeps every mesh taut and open. At first the boat corner was at right angles to the body of the net, but the lamp end being in the deep channel, where the current is stronger, moves downstream more rapidly than the boat end, and gradually the angle closes up and the lamp end is up and downstream in a diagonal line, which crosses, perhaps, two-thirds of the main channel. The man in the boat pulls leisurely along, just fast enough to keep the corner on the net all the time and prevent the net from standing straight up and down stream. As the net is now it presents a sloping wall almost, if not quite, imperceptible to the sight of the fish, and totally impassable unless Mister Salmon would do what many a good man has to do, back down and surround the obstacles he meets. But when the Almighty made the salmon he endowed it with a degree of obstinacy unparalleled in the animal kingdom. The persistent courage of the bulldog and the wild charge of the buffalo when stampeded is nothing compared to the unending rush of the salmon upstream when he makes his annual trip from the ocean to his favorite spawning ground. * * * When the foolish fish meets a gill net he may, perchance, be lucky enough to strike it sideways, and then he will go poking around for a time till he thinks he has the lay of the net, and finding that it runs in a diagonal line, he gives a flirt with his tail, crowds on all sail, and makes a vicious slantwise dive to make up for lost time. The instant he does this he is a doomed salmon. * * * His calculations were all right so far as the main body of the net was concerned, but the fool never stopped to calculate on the corner at the boat end, and so he dashes head foremost into the net, the fatal mesh slips over his head till it is past the gills, and each succeeding struggle only jams him tighter and tighter.

When a fish is first "struck," as the fishermen call it, * * * he will start upstream, towing all the slack of the net, and * * * it is no uncommon thing for a ten or twelve pound fish, when caught near the bottom of the net, to pick up the lead line and struggle to the surface. * * * The small fish fight harder than the larger ones. A huge 30-pounder will often roll into the net and stay there without making a move, but as a rule, when a fish strikes, the bobbing of the corks and the splashing of the water tells the men in the boat that they have another captive. When the boat nears the end of the drift the corner end is let loose, and away they go as hard as they can pull to pick up the lamp end of the net. The first thing to be done is to draw up the

lead line and fold it up to the cork line. Then the boatman [boat-puller] slowly backs up to the net, and as he does so the slack is hauled in. It would not do to pull the net in, for that would draw the meshes open and all the fish would drop out. As the net is hauled in the fish are picked out of the meshes. If not already dead they are killed by a blow over the nose [with a club], for to leave a fish to slowly die in he bottom of a boat spoils its flavor.

As Wilcox observed it, the nets are "laid out" at nearly right angles, or diagonally to the river's course, so that they will intercept the salmon that are running in. Drift-net fishermen set their apparatus only on high water slack, or what they denominate "on the turn of the tide." The gill nets are put out about an hour before high water and generally drift until an hour after. As a rule salmon fishing with drift gill nets can not be profitably prosecuted at other times. The nets are allowed to float with the current for a time specified, when they are hauled into the boat and the salmon are removed. As the fish are gilled they generally die in the net. The mesh determines the size of the salmon, and no small ones are taken in the gill nets, the catch of which is almost entirely large fish of the chinook species. When the fishing is finished and the nets have been hauled into the boats sail is set, and each starts for a scow or cannery to land its catch.

As soon as the fish are disposed of the boats (unless they are at a cannery) run into some shelter and anchor until the conditions are again suitable for fishing. On Saturday, however, all of the men go home and stay there until Sunday afternoon, since fishing is prohibited by law from 6 p. m. Saturday to the same hour on Sunday. It is a beautiful sight to see a thousand or more boats starting for home on a Saturday, their white sails dotting the river for miles.

The nets set farthest down the river are often (if not generally) most successful. This leads to much competition in getting the best berths, and causes the fishermen to take great risks in venturing near the bars upon which the ocean waves always break heavily. The ebb tide runs so strongly at the mouth of the river that the boats can not make way against it; and if the fishermen wait too long before hauling their nets they are sometimes carried upon the bars, where their boats are immediately swamped. Many lives have been lost this way, and a season never passes without its dismal record of disasters.

The catch of the gill-net fishermen varies considerabiy with different seasons, and, as will readily be understood, there is generally a material difference in the results obtained by individual boats. It may be stated, on the authority of the Fishermen's Union, that the average catch per boat in 1888 was about 500 fish, for each of which the canneries paid $1.25. In the early history of the fishery it was not uncommon for a boat to catch four or five times that number.

Set nets are moored in the river so as to intercept the migrating salmon. The same rule applies to these as to the drift nets, so far as clear and muddy water is concerned. If conditions are favorable, fish-

ing goes on night and day, the nets being lifted from time to time, as occasion requires, and the fish taken out.

Seine fishing is carried on upon the bars that are covered at high water, and can not be prosecuted at full flood. It is necessary at such times for the men and horses to go on board the scows and wait until the tide has ebbed sufficiently to enable them to work. The time of beginning varies somewhat at the different reaches, depending upon the depth of water at the stations at high tide. As soon as the beach or bar uncovers, so that the men can successfully wade about with their long-legged rubber boots, operations begin. The most successful time for fishing is when the flood tide begins to run in. It is then practicable to set against the tide, so that the salmon running in with the current will be stopped by the shore end of the seine first thrown over, while the crew of 5 or 6 men in the seine boat are running out and getting on shore the other end of the net.

A dory works in conjunction with the seine boat. In the dory is placed a short section of seine, or the end which is first to be thrown into the water. The location having been determined upon for setting the net, the seine-boat and dory take their positions near each other, the former headed offshore and the smaller boat headed toward the bar or beach where the haul is to be made. At the proper time the two crews begin to throw out the seine. The larger boat pulls offshore at first, circling around against the current, so that the net will nearly form a semicircle, with its convex side reaching out into the river, the first end on the bar, and the last end thrown out being some distance offshore. The men in the dory start directly for shore, as has been stated, and as soon as the short length of net which they have is thrown over they run out as rapidly as possible and haul in on the shore line, which is attached to the end of the seine, one man attending to the landing of the boat.

The object is to get the shore end of the net near the bar as quickly as practicable, and in this endeavor it is not uncommon for the men to jump overboard, even when the water is up to their waists, and begin to haul in on the line, dragging the seine shoreward. When this end of the net is near the shore the sweep of its curve forms a barrier to the progress of fish going up the river, and holds them until the shore-line from the other end of the apparatus is landed. As soon as this is done one or more horses are hitched to the line and begin to pull in the net, and as it comes in there is an effort made to work it against the current as much as practicable. While one horse is pulling in another is going out. In this way the horses are being hitched on one after the other, so that there may be a continuous pull on the seine.

These drag seines are heavy, and being set against the current, as they are, are difficult to manage. It is necessary, however, that all expedition should be used in order to prevent the escape of salmon either by jumping over the cork line or finding some outlet beneath the

foot rope. When the net is finally landed the fish are taken out and loaded on a boat or steamer for transportation to the cannery. Ordinarily about three hauls of a seine can be made on a tide, but sometimes four or five.

From the mouth of the river to the Cascades there is more or less similarity in the methods of fishing; but at the Cascades and The Dalles, some 50 miles farther up the river, the velocity of the water is so great at many points that the salmon seek places where they can most readily pass.

In his report on the salmon fisheries of the Columbia River Maj. W. A. Jones remarks:

> The friction of the rocky bed and shore makes these points immediately alongshore, where one can stand and reach the fish with dip nets attached to long poles as they struggle by. These have been the favorite fishing spots of the Indians from time immemorial. Here the tribes came in summer, pitched their camps, and caught their winter's supply of food. * * * The Indian has been driven from the field, and white men have obtained from the Government the exclusive right to fish. Indians are still employed, and the illustrations show both Indians and white men at work.

When dip-net fishing for salmon the fisherman stands on a rude platform jutting out over the river, and with a long downward stroke or thrust, sweeps the net along with the current as far as he can reach, with the end of the pole on his shoulder, his body being bent strongly forward in the act. If a salmon is caught, its struggles quickly notify the fisherman of the fact, and he immediately pulls up the net and lands the fish in a box built on the platform, or in a bag which is held open by one hand while the contents of the net are dumped with the other hand. Generally, "water hauls" are most numerous, and the fisherman keeps on dipping until too weary to continue it longer. Often, however, when salmon are running plentifully, many hundred pounds are taken in a day by a single individual, though it is not infrequent for a man to work an entire day without getting a single fish. The fish are carried to the packing-house by the squaws, who use large gunny bags suspended on the back by a strap around the forehead.

The success of the dip-net fishery is very much greater than would naturally be supposed. Major Jones says:

> In one day during the season of 1887 at The Dalles fishery 4 nets took 22,000 pounds. In one season 4 nets took 800,000 pounds. At the date of my visit, July 9, 1887, 4 nets had taken 560,000 pounds up to date. During the first 7 days of July of this season [1886] these 4 nets took 114,000 pounds. These figures were given me by Mr. Seufert, the proprietor of the fishery at The Dalles.

The dip-net fisherman occasionally operates squaw nets in connection with other fishing. He sets his squaw net in a position where he can watch it while engaged in dipping, and practically within reach. When a salmon is gilled, he detects it instantly, and, dropping his dip net on the platform, he immediately pulls in on the tackle attached to the pole,

and brings the squaw net to the shore. The fish is then removed and the apparatus again put in position. It has been impracticable to determine the exact quantities of salmon taken by this form of apparatus, since the entire catch of the dip-net fishermen has naturally been aggregated and credited to dip nets. It is, however, believed to be unimportant since only a few squaw nets are used.

The pound nets are lifted once a day, at or near low water. Only two men are required to lift one of these pound nets. The method of operating the pound is the same as that in vogue on the Great Lakes and the Atlantic Coast. It has been so frequently described that it is not deemed necessary to repeat the description here.

As a rule, the fish caught in Baker's Bay are taken to the scows that are moored conveniently near. In some cases, however, they are put on board of the tugs when the latter chance to be present about the time that the pound nets are lifted.

It is said that pound nets take a large percentage of steelheads and bluebacks, but that the chinook salmon caught in them seldom weigh less than 14 pounds apiece.*

In the lower part of the river, in what is called the estuary of the Columbia, pound nets have been found most effective apparatus in the capture of salmon, particularly at Baker's Bay. Sometimes very large catches are obtained. A considerable number of soles, flounders, pike, and suckers are taken incidentally in the pounds, but these are generally thrown away. In 1889 the pound nets in Baker's Bay made an average daily catch of about five shad to a net. These were generally returned alive to the water after the pound was lifted.

In the account of the fish-wheel given in the preceding chapter (on apparatus), the method of catching fish by this device was shown. Fish are caught automatically, "pumped out of the river," as Major Jones has graphically stated it. The wheels run night and day; the catch is chiefly at night, and it has been aptly said that those interested have nothing to do at that time but lie in bed and listen to the salmon dropping into the boxes or scows, sounds that can not fail to be cheering to those whose financial success is thereby assured. In the close season and on Sundays, the wheels are lifted, so that the fish can run by them.

An ingenious device has been adopted by the fish-wheel men to transport their catch to the canneries 2 to 5 miles farther down the river. The salmon are tied together in bunches and these are attached to casks and sent down the stream. Each cannery has its private colors for casks. A sharp lookout is kept for these aquatic transports, and, when one is seen and its color made out, a tug or steam-launch starts out to pick it up and bring the fish to the cannery. As many as 1,500 pounds of fish have been floated down at one time in this way.

---

*Testimony of Mr. M. J. McKinney before the Senate Committee on Relations with Canada.

The catch of bluebacks, silver salmon, and steelheads by the wheels is proportionately much greater than in the apparatus near the mouth of the river. The inference is that the chinook is much depleted in numbers by the catch in the estuary of the Columbia, and that consequently a smaller proportion of them reach the upper waters or even get as far as the Cascades and Dalles. In addition to the salmon, large quantities of sturgeon are caught, and these are now increasing in commercial value and importance. Occasionally a shad is taken while attempting to ascend the river to seek a spawning ground. Lamprey eels also get into the wheels. The catch of the wheels is sometimes enormous. Mr. G. W. Williams is authority for saying that on one occasion, in June, 1886, the catch of a single fish-wheel in one day was 13,935 salmon, weighing 85,000 pounds. Tons of sturgeon are also taken in a single day.

A few men, who fish chiefly for the fresh-fish market at Portland, and some of the salmon fishermen (after the close of the salmon season) fish for sturgeon with trawl lines. Lamprey eels are used for bait; these are generally found in abundance at the Cascades and Dalles, where they crawl out on the rocks or ledges on the river banks, and also at the falls of the Willamette, near Oregon City, where a few fishermen make a business of taking eels and salting them for sturgeon bait. The trawls are hauled at stated intervals.

The Chinese variety of trawl is not baited. It is set about 8 inches to 3 feet above the bottom of the river, so that the hooks may intercept the fish that are nosing about in the vicinity. When a sturgeon comes in contract with one of the sharp pointed hooks it quickly enters his body; stung by the pain, he naturally struggles to free himself, and soon he is impaled with other hooks and finally wound up in the gear and rendered helpless. The struggles of one fish usually result in catching others that may be near, for as he surges the trawl about he is almost certain to fasten the hooks into some other sturgeon.

Clam-digging is followed by 12 Indians who work at Clatsop Beach and produce about 1,800 or 1,900 bushels annually. In 1888 they sold 1,872 bushels. As many more were dug by people living near the beach, making a total of 3,744 bushels, worth \$4,992. Clams are ordinarily sold in boxes holding about 1½ bushels, and the regular price per box is \$2.

Dangers, loss of life, etc.—Nowhere else in the region between San Diego and Puget Sound do the coast fishermen encounter such dangers or meet with such loss of life as on the Columbia. At times the disasters have been appalling, and on the average they exceed all similar losses on the coast within the limits mentioned. The most disastrous season was in 1880, when the fleet of boats was suddenly overtaken by a gale when near the mouth of the river; sails were blown away, some boats were swamped, and others driven helplessly into the breakers, from which there was no rescue. Sixty lives were lost. The

average loss of life is about fifteen annually; but there has been a very gratifying and marked decrease in this particular in recent years, due chiefly to the efforts of the Life-Saving Service.

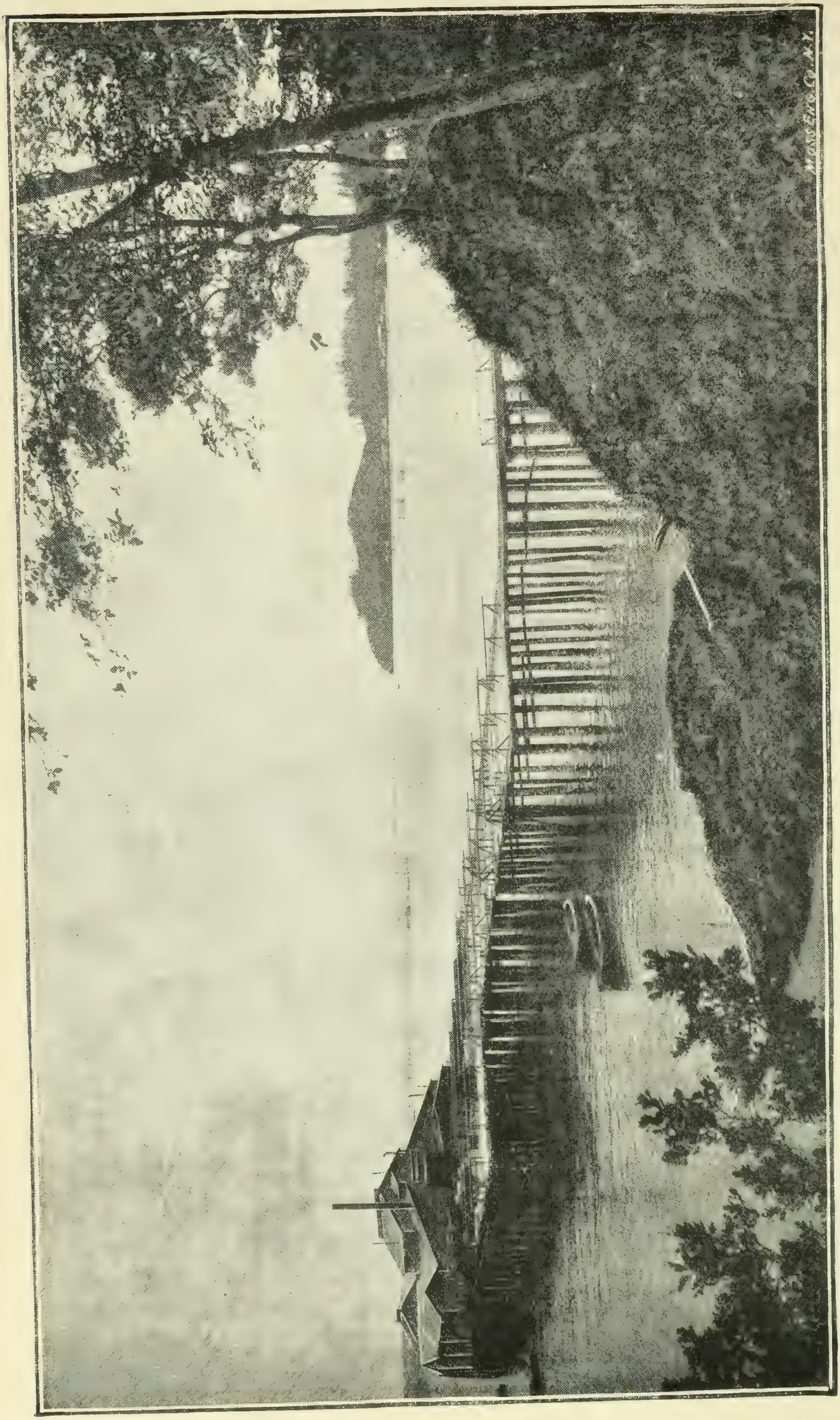
There is a station of the U. S. Life Saving Service at Cape Disappointment, and during the season many fishermen are rescued from peril, who would otherwise lose their lives. One of the surfmen is continually on the lookout on the mountain side facing the ocean and the river mouth. If a vessel or boat is seen in danger a gun is immediately fired for the purpose of notifying the men at the station, in Baker's Bay, at the base of the mountain. When the gun is heard the boat is immediately launched and manned and proceeds to the rescue. With few exceptions, not only the lives of the fishermen but their nets and boats also have been saved, which otherwise would have been destroyed or would have drifted out to sea beyond recovery.

In 1888, 14 gill-net fishermen and 4 who were engaged in operating pound nets lost their lives between Kalama and the outer bars of the Columbia. Most of the boats, however, were picked up, only three being reported as a total loss.

Damage caused by seals and sea lions.—Seals and sea lions are quite numerous in the estuary of the Columbia, and frequently ascend some distance up the river. They are reputed to be very destructive to salmon, particularly those that have been meshed in gill nets, and they do much damage to drift nets and pound nets. There are daily taken from gill nets many salmon with their heads gone, or a large piece bitten out of their throats, the most dainty morsel and one which these aquatic freebooters covet and generally secure. Frequently these animals get tangled in a net, and in their struggles for freedom they seriously injure the apparatus. Sometimes seals and sea lions are caught in the pound nets.

Extent of the salmon fishery, past and present.—The history of the salmon fishery of the Columbia River, if it could be given in detail, would be one of the most interesting chapters that could be compiled on the fisheries of the world. Notwithstanding the brief existence of this fishery as a commercial enterprise, its record is most remarkable. Less than 25 years ago (in 1866) the piscatorial wealth of this noble stream was practically unknown to the world; now the name of "Columbia River salmon" is a household word all over the civilized globe. It has met with welcome and recognition everywhere, and has given world-wide renown to this section of our country. It is possible here, however, to take only a brief glance at the more noticeable points of historical interest, for space will not permit that full discussion which tempts the pen.

Commercial fishing on the Columbia dates from 1861. In that year H. N. Nice and Jotham Reed began packing salted salmon in barrels at Oak Point, 60 miles below Portland. They used one net 50 fathoms long and 3 fathoms deep, with an 8-inch mesh. This was made of



SALMON CANNERY IN BAKER'S BAY, WITH POUND NETS IN DISTANCE.

twine that Mr. Nice spun on an old-fashioned spinning wheel, from flax thread purchased from the stores in the vicinity. The first season's pack amounted to 600 barrels. These met with a limited demand, but sold for $12 per barrel. In 1862, 800 barrels were packed; in 1863, 1,000 barrels, which sold for $10 per barrel; in 1864, 1,800 barrels, at $11; and in 1865 the firm packed 2,000 barrels, but this year a number of other firms engaged in this business, the market was overstocked, and prices fell to $6 per barrel. There is no available record of the pack of these firms in succeeding years, and nothing definite can be learned concerning their continuance in the business. The presumption is that many of them hastily abandoned the enterprise as unprofitable. In these early years the fish were caught almost wholly by Indians, who were usually paid about $40 per month.

The causes which led up to the establishment of salmon canning on the Columbia have been given at length in the discussion of the fisheries of the Sacramento and San Joaquin Rivers. Mention was made there of the building of the first cannery on the Columbia, at Eagle Cliff, in 1866. Then the river literally swarmed with salmon; the wealth of fish was bewildering and the supply seemingly inexhaustible. Nets were made as Nice had made his, and Indians were set at work fishing. The pack was 4,000 cases the first year, 18,000 the next, and 28,000 in 1868.

These were golden years for the pioneers in the trade, for fish could be bought for from 10 to 20 cents, and canned salmon sold at high prices, $14 to $16 per case (of 48 1-pound cans) often being obtained. But competition soon stepped in, and with an increased output new markets had to be sought. The great problems, therefore, which confronted the canners at this time were, first, how to build up a wider demand for their products, and second, how to improve their facilities for packing. Progress was rather slow, but the foundation for the business was solid and the superstructure gradually and surely attained important proportions. For some time, however, the crude and expensive methods of packing continued in use. But, after several years, "Yankee ingenuity" triumphed; improved appliances and methods were introduced, including the use of steam, retorts, etc., and the business was correspondingly improved.

In 1868 the second cannery was built (near Eagle Cliff) by one of the Humes. From that date the establishment of new canneries and the increase in boats, apparatus, etc., were constantly recurring events until the river was literally filled with devices for the capture of salmon, and it finally became apparent that the supply of fish was decreasing to an alarming extent. The assistance of artificial propagation was invoked, but before the results of this could be realized some of the canners transferred their plants from the Columbia to Alaska, where new and prolific fields awaited their enterprise. Still, the industry on the river is of great importance, as the statistics will

show, and, with the aid that fish-culture can give, we may look forward to its continuance and improvement in the future.*

A recent feature of the salmon fishery, which will be mentioned elsewhere in greater detail, is the development of the trade in fresh salmon for market supplies. This has grown to large proportions.

The change in the salmon fishery (so far as a supply of fish is concerned) may, perhaps, best be shown by the change in price paid the fishermen. At first the price per "count" salmon was 10 cents, and per case $8 to $14. In 1888 and 1889, the price per salmon was $1.25, and per case $6. Of course much of this disparity between the price paid for fish and that received for canned goods is due not only to a scarcity of salmon, but also to improvements in manipulating the products. It would not otherwise be possible to sell manufactured goods at a reduced price when the raw material costs ten or twelve times as much as formerly.

The prices of canned salmon have been subject to much fluctuation. Sometimes the supply has exceeded the demand, and weak holders have cut prices in order to effect sales and realize on their stock. An instance of this kind occurred in 1878, when the price fell to $1 per dozen cans, or $4 per case. Speculators took advantage of this and bought up nearly all the salmon on the market, after which the price rose to $1.40 per dozen.

The following statistical statement, which has been compiled from data published by Major Jones, presents many points of historical interest in a condensed form. Together with the statements that follow it, the leading features of the salmon-canning industry, from its inception to the present time (1889), are demonstrated. The figures given by Major Jones differ to some extent from those published elsewhere, but he had exceptional opportunities to secure these data, and they have generally been accepted as correct by those engaged in the trade.

---

*While this report is being prepared news comes that the catch of salmon in the season of 1890 has been much greater than for several years previously. Many, if not most, of the canneries have been oversupplied—at least they could not afford to take all the catch at the prevailing prices—and large quantities of fish have been salted by the fishermen in addition to unusual amounts shipped fresh to all parts of the country, or packed in freezers for future distribution. The pack is reported as being 451,000 cases as against less than 325,000 cases in the previous year, though there were five canneries fewer in operation. It is believed by those competent to judge that this result is directly traceable to artificial propagation at the hatchery on the Clackamas. It is certainly gratifying to all interested in the maintenance of the food supply of the United States, and the continuance of this important industry, that it is within the power of man to increase the supply of fish, and thus to restore what he has been so aggressively active in destroying.

Number of cases of salmon packed on the Columbia from 1866 to 1887, together with value, price per case, price per fish, etc.

Year.	No. of cases.	Value.	Price paid to fishermen per fish.	Selling price per case.	No. of boats.	Cash paid to fishermen during seasons.
			Cents.			
1866	4,000	$64,000	15	$16.00	2	$1,800
1867	18,000	288,000	20	13.00	15	10,800
1868	28,000	392,000	20	12.00	25	16,800
1869	100,000	1,350,000	20	10.00	35	60,000
1870	150,000	1,800,000	20	9.00	50	90,000
1871	200,000	2,100,000	20	9.50	75	120,000
1872	250,000	2,325,000	22½	8.00	100	165,000
1873	250,000	2,250,000	25	7.00	125	187,500
1874	350,000	2,625,000	25	6.50	250	262,500
1875	375,000	2,250,000	25	5.60	300	281,250
1876	450,000	2,475,000	25	4.50	400	337,500
1877	460,000	2,490,000	25	5.20	450	345,000
1878	460,000	2,300,000	25	5.00	550	345,000
1879	480,000	2,640,000	50	4.60	750	720,000
1880	530,000	2,650,000	50	4.80	900	795,000
1881	550,000	2,475,000	60	5.00	1,200	990,000
1882	541,300	2,600,000	75	5.00	1,500	1,217,925
1883	629,400	3,147,000	75	5.00	1,700	1,416,150
1884	620,000	2,915,000	50			930,000
1885	553,800	2,500,000	75			1,301,050
1886	448,500	2,135,000	75			1,009,050
1887	356,000	2,124,000	90			961,200
Total	7,804,000	45,895,000				11,563,525

In addition to the salmon packed in canneries (which in 1888 amounted to 24,190,724 pounds of round fish, with a value to the fishermen of $1,259,932) 933,331 pounds, worth $44,452, were shipped or sold to markets in a fresh condition, and 1,779 barrels (equal to 355,800 pounds of dressed fish) were salted in brine, these having a value of $14,790. The total product was 25,479,855 pounds, with an aggregate value to producers (or fishermen) of $1,319,174. In addition to the above it is estimated that at least 300,000 pounds of fish (chiefly salmon) are used locally by fishermen and their families, or by others who live on the river between the mouth and The Dalles, and of which no definite account can be obtained. These would have a value of $12,000, and would bring the aggregate up to $1,331,174.

Further details are given in the following tabulation, which shows the extent to which each State is interested in the Columbia River fishing and canning industries.

Table showing the extent of the salmon-canning industry on the Columbia River and the fishery dependent thereon, in 1888.

	Oregon.		Washington.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
Canneries	18	$177,057	10	$195,420	28	$372,477
Cash capital	....	670,000	....	340,000	....	1,010,000
Cannery hands	1,037	....	534	....	1,571	....
Fishermen	2,215	....	1,180	....	3,395	....
Boats	919	146,235	516	87,680	1,435	233,915
Drift gill nets	821	240,400	465	130,800	1,286	371,200
Set gill nets	757	22,325	300	7,500	1,057	29,825
Seines	2	1,050	23	24,900	25	25,950
Pound nets	49	37,050	56	52,500	105	89,550
Weirs	3	3,000	12	12,200	15	15,200
Stationary fish wheels	17	53,580	8	35,720	25	89,300
Scow fish wheels	7	10,033	7	9,567	14	19,600
Dip nets	60	1,200	....	....	60	1,200
Horses employed	5	500	78	7,800	83	8,300
Total pounds of salmon taken	15,826,369	816,876	9,653,486	502,298	*25,479,855	1,319,174
Pounds salted	327,900	13,395	27,900	1,395	355,800	14,790
Pounds canned	14,771,054	769,325	9,419,670	490,607	24,190,724	1,259,932
Cases packed	227,559	1,365,354	144,918	869,508	372,477	2,234,862
Cost of packing, including fish	....	1,224,443	....	780,443	....	2,004,886
Estimated profits of canneries	....	140,911	....	89,065	....	229,976

* Not including 300,000 pounds, valued at $12,000, the estimated quantity of fresh salmon consumed locally on or adjacent to the Columbia River.

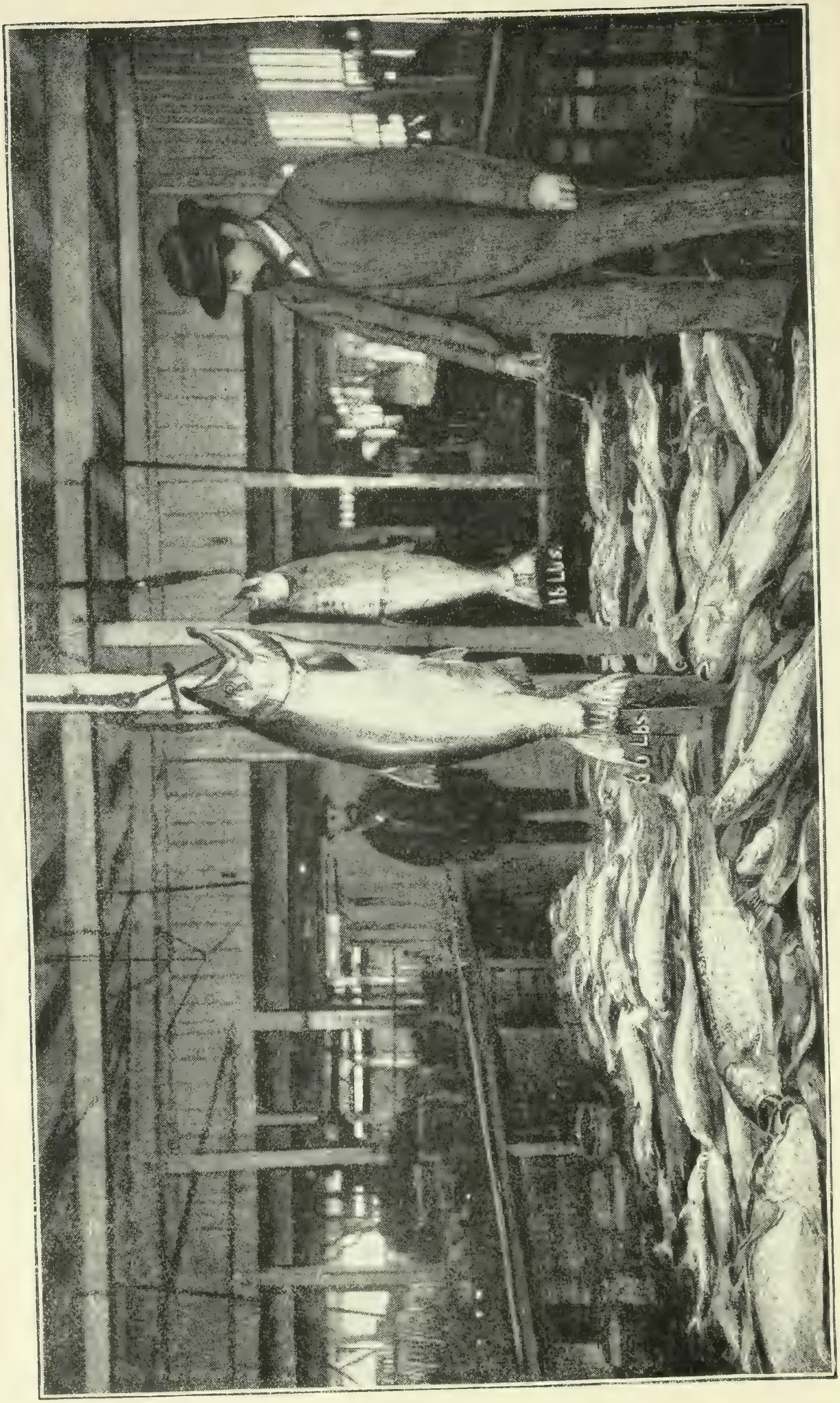
The following table shows the nativity and nationality of the fishermen and factory hands in 1888:

Country.	Fishermen.*		Factory hands.†	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	738	2,486	154	178
United States (Indians)	104	104	....	....
British Provinces	67	24	7	4
Russia	714	300	4	....
Austria	240	155	1	....
Norway	402	121	....	....
Sweden	932	152	15	5
Greece	132	56	....	....
Germany	47	18	5	....
Italy	92	79	1	....
Portugal	44	26	....	....
France	4	4	1	1
Denmark	9	....	....	....
China	13	13	1,383	1,383
	3,538	3,538	1,571	1,571

* These figures include 51 persons employed on small steam vessels in transporting salmon to the canneries.

† The factory hands credited to the United States include 15 women.

As a matter of interest in connection with the salmon industry and the money disbursed in its prosecution, and as a fair illustration of its importance, the following is given on the authority of the Daily Astorian, of Astoria, Oregon, which claims that the statement is a close estimate



INTERIOR OF CANNERY.

of the amount of money expended on the Columbia River during the season of 1886:

Items.	Amount.	Items.	Amount.
Material:		Material—Continued:	
Tin plate, 74,000 boxes, at $5.25	$388,500	Insurance	$32,376
Salmon twine	205,200	Hauling	12,540
Cotton twine	25,000	Freight	5,000
Lines	26,600	Labels	32,400
Lead for lines	7,500	Boxes	67,500
Floats	4,000	Taxes	11,400
Boats, wear and tear, paint, repair, etc	38,000	Total cost of material	1,020,320
Tan-bark for nets	1,900		
Pig tin for making solder	50,122	Labor:	
Lead for making solder	10,450	Knitting nets, 228,000 fathoms, at 22½ cents	128,250
Salt, Liverpool and coarse	2,000		
Lacquer	8,550	Catching salmon with cannery nets	400,000
Turpentine	6,460		
Cord wood	19,760	Catching salmon with private nets	300,000
Hard coal	1,862		
Charcoal	15,200	Salvage and hire of detectives	5,700
Acid and zinc	4,000	White labor outside of fishing	93,956
Oils of various kinds	4,000	Other labor outside of fishing	142,000
Improvements and necessary repairs	38,000	Total cost of labor	1,069,906
Copper and making up	2,000		

Salmon canning.—The following account, by Jordan and Gilbert, of the process of salmon canning on the Columbia is as applicable to-day as when written, since there have apparently been no noteworthy changes in this particular in recent years:

The salmon are brought to the wharf, usually in the morning, counted, and thrown in a heap. A Chinaman then takes each, cuts off its head, tail, and fins, and removes the viscera, throwing them into a large tub. Some of the cutters become very expert and will clean 1,700 fish per day.

Next the fish are washed and sometimes scraped with a knife, though the scales are not removed. Then they are placed in a trough in which several knives acting like a feed-cutter cut the salmon into sections as long as the height of a can. These sections are set on end and split by a Chinaman into about three pieces, one large enough to fill a can, the others smaller.

These fragments are placed on tables and Chinamen there fit them into the cans. Other Chinamen put on the covers, and still others solder them. In some canneries the soldering is done by machinery. In this case the cans are rolled along by an iron chain belt and the end rolls in the melted solder. Most of the canners think hand-soldering safer, although much more labor is required.

After soldering, the cans are placed in hot water and carefully watched to see if any bubbles rise from them indicating a leak in the can. If perfect, the can is placed in an iron tank and boiled in salt water, it being possible to raise salt water to a higher temperature than fresh. After being boiled about one and one-fourth hours the can is taken out and vented, the pressure within driving out all the air through the aperture made. The hole is immediately soldered up, and the cooking completed by again boiling (one and one-half hours) in salt-water kettles. If the process of cooking were completed before the cans were vented, the pressure would be sufficient to burst the cans.

The cans are afterwards tested by being tapped on the head with a large nail. If the can is leaky it gives back a "tinny" sound easily recognized. This is a very

important process, as some canneries lose largely by careless testing, the leaky cans afterwards bursting and damaging more or less the entire box. The cans are usually tested three or four times, and by different workmen. A leaky can is simply sent back to be soldered.

The cans are all made on the premises from sheet tin imported for that purpose. The cost of the tin can is estimated at one-ninth of the cost of the can of salmon.

On an average three salmon fill one case of forty-eight 1-pound cans.—(The Fisheries and Fishery Industries of the United States, section V, vol. 1, page 747.)

Salting salmon.—Curing salmon by salting them in barrels, and having them covered with brine or pickle, is the original method adopted by white men in this region. The fish are split, eviscerated, and washed or soaked sufficiently to make them perfectly clean and free from blood. They are then packed flesh side up and salted. In a few days they are thoroughly "struck" with salt and ready to be packed, repickled, and otherwise prepared for shipment.

Smoking salmon.—A few salmon are smoked. These are first salted sufficiently to preserve them; they are then hung up in a smoke house—a rough wooden shanty—and smoked for several days over a smudge fire, usually of damp oak. They are then packed in boxes for shipment.

Salting sturgeon.—Sturgeon are salted in brine; they are also salted in bulk or kench and sent East for smoking. In 1888 722 barrels (equal to 144,400 pounds) were pickled and 43,875 pounds were dry-salted.

Freezing fish.—In the fall of 1888 a sturgeon-fishing camp was established by a New York firm at Oneonta, Oregon, in the immediate vicinity of the railway station. This camp was 12 miles below the Cascades and 33 miles, by rail, from Portland. Its proximity to the railroad gave the requisite facilities for shipping its products to the interior or the markets along the Atlantic Coast. The enterprise was started for the purpose of testing the feasibility of shipping fresh frozen sturgeon to distant points. The first shipment was reported to have been made January 16, 1889, and up to May 24 of that year 85 tons of fish had been sent East. This is the first attempt to transport sturgeon in this way from the Columbia. Notwithstanding the high freight rates across the continent, the venture was reported pecuniarily successful during the winter, when sturgeon were scarce in eastern waters. During the summer, however, there is an abundance of eastern-caught or lake sturgeon in the Atlantic or Central States markets, and at this time shipments were not made from Oneonta, except the sturgoen roe, which was salted as caviare and sent East.

The sturgeon used for shipment weighed from 50 to 400 pounds each, for which the price per fish (regardless of size) was 40 cents in 1888–89. They were caught on trawls set near the camp, and also in the salmon wheels a few miles farther up the river. The latter are sent down stream in bunches attached to floats, like the salmon. The fish are first beheaded, eviscerated, and skinned. The backbone is then removed and the flesh cut into suitable sections for freezing. These sections are packed into galvanized iron pans 24 inches long, 16 inches

wide, and 5 inches deep. The pans are then put into a freezer charged with ice and salt and their contents are frozen into solid blocks of fish weighing about 60 pounds to each pan. The process is precisely similar to that in vogue on the Great Lakes for freezing fish. When frozen the fish are removed from the pans and packed in boxes—four blocks to each box—and then loaded into refrigerator cars that go direct to New York City. The cars are charged with ice and salt to keep the temperature below the freezing point. In midwinter the cars do not usually require to be recharged before they reach their destination, but when the weather begins to grow warmer in spring it is sometimes necessary to recharge with ice and salt once or more while in transit. Shipments have been reported as arriving in good order. This system of shipping frozen fish will doubtless come into extensive use for transporting salmon.

Secondary products.—Comparatively little effort has yet been made to utilize the waste products of the canneries. A small business is, however, carried on at Astoria, where an attempt has been made to use the refuse of the canneries for the manufacture of oil and fertilizer; but the price paid for the refuse is small, consequently the bulk of the material is dumped into the river. Notwithstanding this, and although the business was conducted in a somewhat primitive manner, enough material was obtained to make 8,000 gallons of oil (chiefly from salmon heads) and 90 tons of fertilizer. The oil was worth 22½ cents per gallon and the fertilizer had a market value of $20 per ton. With proper effort and requisite facilities for collecting the refuse of the canneries along the river, a profitable and extensive business could probably be supported, and much useful material produced from waste that now pollutes the river.

The fish wheels often take in a day many tons of sturgeon less than 50 pounds in weight. Such are not marketable, and are now thrown into the river. Their utilization would be a blessing to the fisherman, for they now help to contaminate the water. Many sturgeon are also taken near the mouth of the Columbia in pound nets, gill nets, etc. Their size and strength often enables them to tear the nets in their efforts to get free. They are, therefore, considered as pests by the fishermen of the lower river, who never save such fish, but generally knock them on the head and throw them back into the water.

The roe of sturgeon is saved to some extent and cured as caviare.

Markets and disposition of products.—The two principal markets and distributing centers on or near the Columbia are Astoria and Portland. From these points most of the fish products of the region are shipped over the United States or sent to foreign countries. Portland consumes a very considerable amount of fresh fish, and, with the exception of sturgeon, the greater part of the fresh products received there is consumed locally.

Astoria is not well provided with fish markets, probably because so many of its people are fishermen and supply themselves with fish.

The following is a statement of the receipts of fish at Astoria, other than those landed at the canneries, during 1888:

Description.	Pounds.
Salmon (fresh)	50,000
Salmon (salted in barrels)	200,000
Shad (fresh)	5,000
Perch (fresh)	500
Sturgeon (fresh)	3,000
Clams ... bushels	1,872

With the exception of salt salmon the foregoing products were consumed locally. It is estimated that fully 100,000 pounds of salmon and other fish in addition to the above are eaten by the fishermen and their families, of which no account can be obtained.

The movements of fish products and their distribution may be understood from the following:

Fresh salmon shipped from Cascade Locks in 1888, via Pacific Express Co.:	*Lbs.*
To points west of the Missouri River	140,732
To points east of Missouri	4,105
Shipped from The Dalles by the same company:	
Points west of Missouri	88,233
Points east of Missouri	2,430
Fresh salmon (by express)	236,000
Salt salmon (by rail freight)	100,000

The "salmon" shipped East in a fresh condition are mostly steelheads, which are much better for market purposes than for canning.

There is a growing demand for canned salmon in the central and eastern portion of the United States, as shown by the shipments, while the direct consignments to England have steadily declined. The Oregonian (Portland, Oregon) of January 2, 1888, stated that the shipments of salmon in cases for three years—1885 to 1887, inclusive—were as follows:

Year.	To San Francisco.*	Eastward.	England.	Total.
1885	100,508	†270,238	227,037	597,783
1886	110,669	280,870	157,056	548,595
1887	51,964	308,357	125,825	486,146

* San Francisco is a distributing center whence salmon are shipped to Australia or other countries.

† Includes 39,175 cases shipped to New York by sail vessels.

The following statistical statements apply to the fisheries of Oregon that are prosecuted on the Columbia River:

Persons employed.

Country.	Fishermen on vessels.		Fishermen on boats.		Shoresmen.		Total.	
	Nativity.	Nationality.	Nativity.	Nationality.	Nativity.	Nationality.	Nativity.	Nationality.
United States	25	29	282	1,429	102	126	409	1,584
United States (Indians)			54	54			54	54
British Provinces	1		47	9	7	4	55	13
Austria			196	132	1		197	132
Denmark			9				9	
France			2	2	1	1	3	3
Germany	2		36	16	5		43	16
Greece			86	33			86	33
Italy			86	73	1		87	73
Norway			188	55			188	55
Portugal			44	26			44	26
Russia			471	207	4		475	207
Sweden	1		593	58	15	5	609	63
China	2	2	10	10	901	901	913	913
Total	31	31	2,104	2,104	1,037	1,037	3,172	3,172

Apparatus and capital.

Designation.	No.	Value.
Vessels (tonnage, 145.85)	9	$40,550
Outfit		7,900
Boats	1,025	169,885
Seines	2	1,050
Gill nets	1,578	262,725
Weirs and pound nets	52	40,050
Salmon wheels	24	63,613
Minor apparatus		2,900
Shore property		463,594
Cash capital		655,000
Total		1,707,267

Products and values.

Species.	Pounds.	Value.
Fish:		
Salmon, fresh and canned	15,698,469	$811,481
Salmon, pickled	327,900	13,395
Brook trout, fresh	12,500	1,562
Sturgeon, fresh	784,424	11,796
Sturgeon, pickled	186,200	3,724
Smelt, fresh	180,000	5,400
Perch, fresh	3,000	300
Shad, fresh	10,000	500
Eels, salted (bait)	5,000	250
Tomcod	30,000	1,600
Total	17,237,493	850,008
Miscellaneous:		
Crayfish ... dozen	4,775	716
Clams ... bushels	7,488	7,325
Oil ... gallons	8,000	1,800
Fertilizer ... tons	90	1,800
Caviare ... pounds	96,760	4,840
Total		16,481
Grand total		866,489

43. FISHERIES OF THE WILLAMETTE RIVER.

Geographical characteristics.—The Willamette is formed by the McKenzie River and Middle Fork, which rise in the Cascade range of mountains and unite about 5 miles north of Eugene City, in Lane County. From its confluence the river flows in a northerly direction and forms the boundary line between Linn and Marion Counties on the right, and Benton, Polk, and Yam Hill on the left. Finally it intersects Clackamas and Multnomah Counties and empties into the Columbia River about 13 miles north of Portland, traversing a distance, from the source of the Middle Fork to its mouth, of about 300 miles. The river is navigable as far as Oregon City, 13 miles above Portland, at which town there is an obstruction in the form of falls about 40 feet high. Steam vessels ply on the river from above the falls to Eugene City, about 200 miles above its mouth.

Importance of the fisheries.—The fisheries of this river are confined almost entirely to the pursuit of salmon, although a few barrels of lamprey eels are annually taken at the falls near Oregon City, and salted for use as bait in the sturgeon fishery on the Columbia River.

No account has been made of the fishing on the river between the falls at Oregon City and Eugene City, nor between Portland and the mouth of the river, because in the first instance no commercial fishery is carried on, and in the second case the same men employed on the Willamette also fish on the Columbia, and on account of the intricacy of the problem and slight importance of the industry it is not deemed desirable to separate the catch.

Species, seasons, etc.—The salmon in the Willamette are the same as those in the Columbia. Oregon pike, suckers, whitefish, and lamprey eels also occur. Salmon are the most important species, and, with the exception of a few eels, no other fish are caught. During April and May the catch is confined chiefly to the quinnat salmon, and after that steelheads and bluebacks are caught in greater numbers. In the spring of 1889 the run of salmon was greater than for many years, and during the month of April the catch was larger than for the whole of the preceding year. This abundance was attributed by the fishermen to unusually fine weather and a favorable condition of the water.

Fishing grounds.—The account of the fisheries embraced within this description applies only to the Willamette between Portland and Oregon City, as well as to the fisheries at the mouth of the Clackamas, the same men taking fish indiscriminately in both rivers. From the falls at Oregon City to the source of the stream, no commercial fishing is prosecuted, and while many local species, as trout, Oregon pike, etc., are abundant along the whole length of the stream, no fishing grounds of commercial importance are found. The grounds below Portland as far as the mouth of the river are not considered here, because the men who operate on the Columbia also fish on the lower reaches of the Wil-

lamette, and for this reason this section of the river has been mentioned in connection with the fishing grounds of the larger stream.

Disposition of products, etc.—Nearly all of the salmon caught on the Willamette, within the limits under consideration here, are shipped in a fresh condition to Portland, where they are sold for immediate consumption in the markets of that city. The salmon catch is all sent to the Portland markets. A small freighting steamer plying between Portland and the upper river, in addition to its regular business, also at times transports fish from the fishermen along the river to the markets, receiving 2 cents for each fish carried.

Portland as a fish market.—Portland is a beautiful city located on the Willamette, about 12 miles from its junction with the Columbia. It has a population of between 60,000 and 70,000 and is the most important fish market in the region, so far as local consumption is concerned. In addition to the quantities of fresh fish consumed in the city, more or less are shipped by the dealers to the interior towns and to localities along the coast, including San Francisco. Portland is quite a noted railroad center, and naturally it becomes a shipping center for fish (canned, fresh, and pickled) that are sent to the Eastern States. It has considerable capital invested in canneries in Oregon and Washington, a large portion of the pack of which is sent through that city, either for shipment by rail to the Eastern States or for exportation to Europe.

The following tables give some idea of the fish trade of this city:

Quantities and values of the principal species of fish, etc., received at Portland in 1888.

Species.	Pounds.	Value.
Salmon, fresh*	728, 723	$36, 436
Salmon, pickled	65, 000	3, 250
Brook trout and salmon trout, fresh	12, 500	1, 562
Sturgeon, fresh	778, 424	11, 676
Sturgeon, salted	186, 200	3, 724
Smelt, fresh	150, 000	3, 000
Perch, fresh	2, 500	200
Crayfish	14, 325	716
Oysters, in shell	190, 700	5, 721
Total	2, 128, 372	66, 285

*216,892 pounds came from the Willamette and Clackamas Rivers, and 511,831 pounds from the Columbia.

Monthly shipments of fresh salmon from the Willamette River to Portland, Oregon, in 1888 *and* 1889.

Month.	1888.		1889.	
	Number.	Pounds.	Number.	Pounds.
April	5, 632	101, 378	14, 348	258, 264
May	2, 448	44, 064	2, 526	45, 468
June	707	8, 484		
October	1, 094	13, 128		
November	808	9, 696		
December	2, 487	29, 844		
Total	13, 176	206, 594	16, 874	303, 732

Quantities of fish and oysters forwarded to Portland over the lines of the Oregon Railway and Navigation Company in 1888.

Month.	Sturgeon.		Salmon. (fresh).	Smelt (fresh).	Oysters.
	Number.	*Pounds.*	*Pounds.*	*Pounds.*	*Sacks.*
January	263	18,745	1,400	....	....
February	1,998	151,626	29,250	14,250	....
March	1,088	88,410	1,100	2,000	287
April	224	20,161	24,945	....	332
May	304	32,175	37,130	....	351
June	245	25,425	92,045	....	....
July	342	35,130	23,280	....	164
August	328	32,313	5,085	....	....
September	295	24,092	2,550	....	318
October	278	22,975	37,686	....	455
November	221	18,807	1,600	....	....
December	207	18,595	4,960	....	....
Total	5,793	488,454	260,431	16,250	1,907

In addition to the above the following quantities of fish, not tabulated by months, reached Portland by the same routes: Salt sturgeon, 43,875 pounds and 710 barrels; salt salmon, 210 barrels.

The following tables show the extent of the fisheries of that portion of the Willamette River included in the preceding discussion:

Persons employed.

Country.	Nativity.	Nationality.
United States	46	60
United States (Indians)	10	10
British Provinces	8	....
France	4	4
Germany	2	2
Sweden	10	4
Total	80	80

Apparatus and capital.

Designation.	Number.	Value.
Boats	40	$800
Gill nets	190	5,000
Total	....	5,800

Products and values.

Species.	Quantity.	Value.
Salmon, fresh .... pounds	228,609	$11,430
Salmon, salted .... barrels	35	280
Eels, salted .... do	50	500
Total	....	12,210

IV.—THE FISHERIES OF WASHINGTON.

GENERAL REMARKS.

The fisheries of Washington, while of less extent than those of the other Pacific States, are of great and growing importance. In the salmon and other shore fisheries, and in the canning industry, the State is a formidable rival of Oregon, while its vessel fisheries for fur seals and halibut contribute to the industry of the Puget Sound region. Different phases of the fisheries are shown in the accompanying tables, which include figures for the vessels from New England ports that made their headquarters on Puget Sound in 1888. and really constituted a part of the fishing fleet of this State.

Persons employed in the fisheries of Washington in 1888.

Section.	Fishermen.		Shoresmen.	Total.
	On vessels.	On boats.		
Columbia River	13	1,390	534	1,937
Shoalwater Bay	....	298	125	423
Chehalis River and Gray's Harbor	....	236	176	412
Puget Sound	270	647	141	1,058
Total	283	2,571	976	3,830

Nativity and nationality of persons employed in the fisheries of Washington in 1888.

Country.	Fishermen.		Shoresmen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	837	1,635	104	104
United States (Indians)	612	612	....	....
British Provinces	40	26	2	2
South America	6	6	....	....
Austria	44	23	....	....
France	2	2	....	....
Germany	13	2	....	....
Greece	53	30	....	....
Italy	69	51	....	....
Norway	287	109	....	....
Portugal	26	16	....	....
Russia	339	156	....	....
Sweden	520	180	6	6
China	1	1	864	864
Japan	5	5	....	....
Total	2,854	2,854	976	976

Apparatus and capital employed in the fisheries of Washington in 1888.

Section.	Apparatus of capture.								
	Gill nets.		Seines.		Weirs and pound nets.		Salmon wheels.		Value of minor apparatus.
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	
Columbia River	765	$138,300	23	$24,900	68	$64,700	15	$45,287	
Shoalwater Bay	108	14,850			42	22,000			$875
Chehalis River and Gray's Harbor	170	23,375			37	25,900			
Puget Sound	87	10,820	36	19,300	12	9,800			2,070
Total	1,130	187,345	59	44,200	159	122,400	15	45,287	2,945

Section.	Vessels.				Boats.		Other property.		Total capital invested.
	No.	Net tonnage.	Value.	Value of outfit.	No.	Value.	Value of land, buildings, accessories, etc.	Cash capital.	
Columbia River	3	64.05	$17,000	$2,020	516	$87,680	$203,220	$340,000	$923,107
Shoalwater Bay					187	19,415	43,000	55,000	155,140
Chehalis River and Gray's Harbor					85	10,125	44,000	70,000	173,400
Puget Sound	14	688.68	54,600	29,500	414	28,660	43,000	68,000	265,750
Total	17	752.73	71,600	31,520	1,202	145,880	333,220	533,000	1,517,397

Products of the fisheries of Washington in 1888.

Species.	Columbia River.		Shoalwater Bay.		Chehalis River and Gray's Harbor.		Puget Sound.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Fish.								
Cod, fresh .... pounds							239,400	$10,820
Halibut, fresh ...... do							920,000	21,800
Halibut, salted ..... do							300,000	10,100
Salmon, fresh ...... do	9,725,586	$504,903	1,755,000	$52,650	2,775,000	$83,250	1,930,250	41,005
Salmon, salted ...... do	27,900	1,395					106,000	3,410
Other kinds, fresh .. do							1,135,200	33,775
Total	9,753,486	506,298	1,755,000	52,650	2,775,000	83,250	4,630,850	120,910
Mammals.								
Fur-seal pelts ... number							5,351	29,458
Sea-otter pelts ...... do							30	3,450
Total							5,381	32,908
Mollusks and crustaceans.								
Crabs .... number							7,500	570
Clams .... pounds							300,000	3,200
Oysters .... do			3,276,200	65,524			790,000	21,050
Shrimps .... do							5,000	500
Total			3,276,200	65,524				25,320
Secondary products.								
Dogfish oil ..... gallons							10,000	4,000
Grand total		506,298		118,174		83,250		183,138

Summary of the products of the fisheries of Washington.

Species.	Quantity.	Value.	Species.	Quantity.	Value.
Fish.			*Other products.*		
Cod, fresh........pounds..	239, 400	$10, 820	Fur-seal pelts....number..	5, 351	$29, 458
Halibut, fresh........do....	920, 000	21, 800	Sea-otter pelts.......do....	30	3, 450
Halibut, salted.......do....	300, 000	10, 100	Crabs...............do....	7, 500	570
Salmon, fresh........do....	16, 185, 836	681, 808	Clams ....pounds..	300, 000	3, 200
Salmon, salted........do....	133, 900	4, 805	Oysters..............do....	4, 066, 200	86, 574
Other kinds, fresh...do....	1, 135, 200	33, 775	Shrimps.............do....	5, 000	500
			Dogfish oil.......gallons..	10, 000	4, 000
Total	18, 914, 336	763, 108	Total................	....	127, 752
			Grand total	....	890, 860

Statistics of the salmon-canning industry of Washington in 1888.

Location of canneries.	No. of canneries.	No. of factory hands.	Salmon used for canning.		Canned salmon placed on market.	
			Pounds.	Price paid to fishermen.	Cases.	Value.
Columbia River	10	534	9, 419, 670	$490, 607	144, 918	$869, 508
Shoalwater Bay........................	3	125	1, 575, 000	47, 250	22, 500	129, 375
Gray's Harbor and Chehalis River........	4	176	2, 775, 000	83, 250	37, 000	212, 750
Puget Sound	4	141	1, 538, 250	26, 665	21, 975	126, 356
Total	21	976	15, 307, 920	647, 772	226, 393	1, 337, 989

45. FISHERIES OF THE COLUMBIA RIVER.

These fisheries have been so fully discussed elsewhere that it is not necessary to further allude to them. In order that the relative importance of the fisheries of the two States may be better understood, however, it is deemed advisable to show in the following tables the extent of the fisheries of Washington on the Columbia.

Persons employed.

How engaged.	No.
Vessel fisheries..	13
Shore fisheries..	1, 390
Canneries	534
Total	1, 937

Nativity and nationality of persons employed.

Country.	Fishermen. On vessels. Nativity.	Fishermen. On vessels. Nationality.	Fishermen. On boats. Nativity.	Fishermen. On boats. Nationality.	Shoresmen. Nativity.	Shoresmen. Nationality.	Total. Nativity.	Total. Nationality.
United States	12	12	419	1,016	52	52	483	1,080
United States (Indians)			50	50			50	50
British provincials			29	15			29	15
Austria			44	23			44	23
France			2	2			2	2
Germany			9	2			9	2
Greece			46	23			46	23
Italy			6	6			6	6
Norway			214	66			214	66
Russia			233	93			233	93
Sweden			338	94			338	94
China	1	1			482	482	483	483
Total	13	13	1,390	1,390	534	534	1,937	1,937

Apparatus and capital.

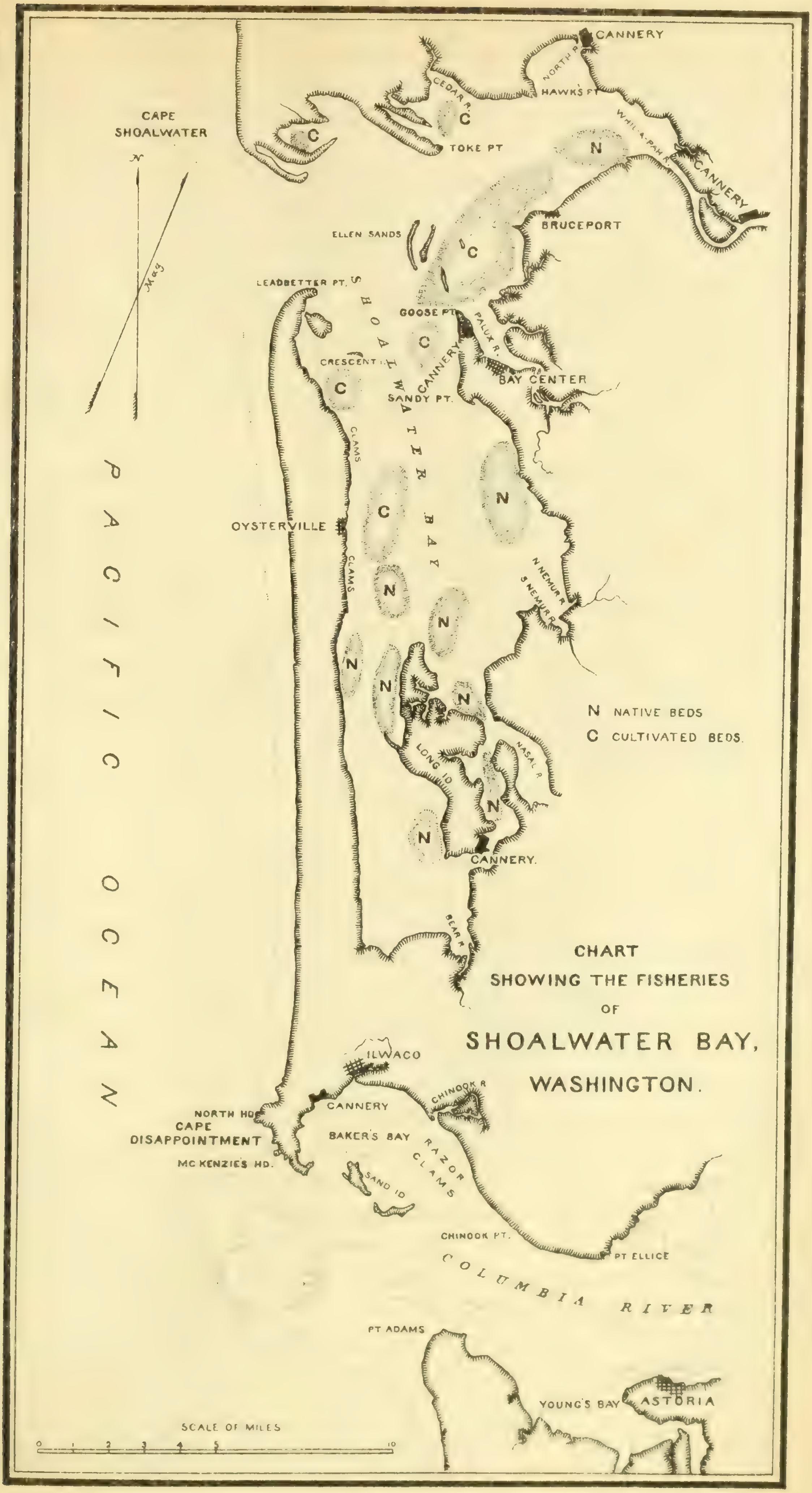
Designation.	No.	Value.
Vessels (tonnage, 64.05)	3	$17,000
Outfit		2,020
Boats	516	87,680
Seines	23	24,900
Gill nets	765	138,300
Pound nets	68	64,700
Salmon wheels	15	45,287
Shore property and accessories		203,220
Cash capital		340,000
Total		923,107

Products and values.

Species.	Pounds.	Value.
Salmon, fresh and canned	9,725,586	$504,903
Salmon, pickled	27,900	1,395
Total	9,753,486	506,298

46. FISHERIES OF SHOALWATER BAY.

This body of water is inclosed on the west by a long, narrow sand spit thrown up by the action of the Pacific tides, extending from the headland of the Columbia River entrance (Cape Disappointment) to Leadbetter Point, at the mouth of Shoalwater Bay. The spit varies in width from ¾ to 1 mile, and is about 17 miles long. The bay proper is about 24 miles long, from north to south, and from 3 to 5 miles wide. It is located in Pacific County. The bay is shallow, excepting in the main channel, and in many places extensive sand-bars and mud-flats are to be found. In the southern part, near the eastern shore, is a large islet, known as Long Island. Eight rivers flow into the bay. Bear River is located in the extreme southeastern part of the bay; Nasal River is


CAPE SHOALWATER
N
Mag
PACIFIC OCEAN
CANNERY
NORTH R
HAWKS PT
CEDAR R
C
TOKE PT
WHIL-A-PAH R
N
CANNERY
BRUCEPORT
ELLEN SANDS
C
LEADBETTER PT.
SHOALWATER BAY
GOOSE PT
PALUX R
C
CANNERY
CRESCENT
C
BAY CENTER
SANDY PT.
CLAMS
N
C
OYSTERVILLE
CLAMS
N
N NEMUR R
S NEMUR R
N
N
N
N
N NATIVE BEDS
C CULTIVATED BEDS.
LONG ID
NASAL R
N
N
CANNERY.
BEAR R
CHART
SHOWING THE FISHERIES
OF
SHOALWATER BAY,
WASHINGTON.
ILWACO
CANNERY
CHINOOK R
NORTH HD
CAPE
DISAPPOINTMENT
BAKER'S BAY
RAZOR CLAMS
MC KENZIE'S HD.
SAND ID
CHINOOK PT.
PT ELLICE
COLUMBIA RIVER
PT ADAMS
YOUNG'S BAY
ASTORIA
SCALE OF MILES
0 1 2 3 4 5 10

next on the east side, and opposite Long Island; the North and South Nemur Rivers occur next, a few miles north of Nasal River; the Palux River enters the bay opposite Leadbetter Point, and the Whilapah River is situated in the northeastern part of the bay. On the north are the North and Cedar Rivers.

Fishing centers.—Bay Center, on the eastern side of the bay, near the mouth of the Palux River, is the principal center for the shipment and distribution of the local fishery products. At this point the major part of the oyster trade is carried on. Small sloop-sailboats bring oysters from the beds on the bay and temporarily deposit them in racks and cribs at this town until wanted for market. Some years ago Oysterville enjoyed a monopoly of this trade, but the center of activity is no longer located there. A few other points on the bay also have oyster interests of small value.

Importance of the fisheries.—Salmon and oysters are the only objects of fishery commerce of this bay. The products of the salmon fishery in 1888 amounted to 1,755,000 pounds, valued at $52,650, or an average of $355 per man engaged in the fishery that year; 148 fishermen were employed, who used 108 gill nets, 42 pound nets, and 54 boats; the whole value of apparatus being about $41,000. The taking of oysters is still the most important industry in the bay, so far as the value of the product is concerned, although it is surpassed by the salmon fishery in the amount of capital invested. The total output of this fishery in 1888 was 32,762 sacks, valued at $65,524; it employed 150 men, who used 23 sloops, 61 bateaux, and 49 rowboats, the whole having a value of $14,920.

Species, seasons, etc.—The following species of fish occur in the bay and its tributaries in proper season: Salmon, salmon trout, mountain trout, flounders, tomcod, porgies or perch, sardines, smelt, herring, soles, skates, and sturgeon. About 80 per cent. of the catch is the silver salmon (*O. kisutch*), while the quinnat or "black" salmon (*O. chouicha*) comprises about 20 per cent. of the yield. The former species weighs from 8 to 16 pounds, averaging 12 pounds, and the latter from 14 to 50 pounds, averaging 22 pounds. The silver salmon are found from October to December, spawning during the months of November and December. The quinnat salmon occur from August to October, being most abundant from the first to the middle of August. A few steelheads (*S. gairdneri*) and humpback salmon (*O. gorbuscha*) are sometimes taken.

Of shellfish, there are found oysters, and razor and soft-shell clams.

Fishing grounds.—The fishing grounds are located in all sections of the bay. Salmon gill nets are set across the entrance to the bay and at other available sections. Pound nets, 42 of which were in operation, are generally located in the rivers.* Nearly all the natural oyster beds

* No charts of Shoalwater Bay were available of a scale sufficiently large to permit the location of the pound nets. For the same reason the definition upon the map of many other interesting data had to be omitted.

are in the vicinity of Long Island. The artificial or transplanted beds are on the west side of the bay, near Oysterville, and on the east side, between the mouths of the Palux and Whilapah Rivers. Clams are found at different points along the west shore of the bay.

Fishermen, lay, etc.—The salmon fishermen receive 60 cents apiece for quinnat salmon and 30 to 33 cents each for silver salmon; this is about 3 cents a pound for the fish as they come from the water. The earnings of the oystermen are governed entirely by the quantities taken and the demand in the market.

Apparatus, boats, etc.—The gill nets, pound nets, boats, etc., are essentially the same as those already described for other localities.

Methods.—The methods of fishing for salmon, both by pounds and gill nets, are practically the same as on the Columbia and other points along the coast.

The oyster industry.—Shoalwater Bay is celebrated on the Pacific coast for its oysters, which occur abundantly there on natural beds. For a number of years the oyster supply of San Francisco was obtained solely from this source. Since the eastern oyster was first successfully transplanted to beds in San Francisco Bay, however, the importance of the Shoalwater Bay oyster fishery has steadily declined in about the same ratio as the importation of Atlantic oysters has increased.

The oysters are small, and have a strong flavor that makes them objectionable to an uncultivated taste, but nevertheless they are highly prized by the natives of the coast. The most extensive natural oyster-beds on the west coast are in this bay, mostly in the southern section in the vicinity of Long Island. By referring to the accompanying chart, (plate XLI) it will be seen that a number of cultivated or transplanted beds are marked. The transplanting of oysters from the natural to the cultivated beds has become necessary because the bottom of the bay near the natural beds is rapidly filling up with vegetable growths, and many areas which were once profitable oyster grounds are now worthless. Natural oyster beds are protected by law between June 15 and September 1, during which time the light demand in the markets is supplied from planted beds. Oysters can not be taken from the natural beds during the close season; but private beds can be worked by their owners, and are also protected by law.

In the oyster fishery the methods are somewhat similar to those in vogue in San Francisco Bay. During the warm months oysters are taken by hand from the beds, which are exposed at low tide. In the winter they are gathered chiefly with tongs. While the tide is in, or high, large bateaux are towed to the oyster beds and anchored, where they ground at low tide. The men then gather the oysters from the uncovered beds, and cull and load them on the scows. When there is a sufficient quantity on the craft, they are towed to the home station, where the oysters are unloaded into "live-cars" until ready for market or shipment. Sometimes the bateaux are sailed across the bay with their

freight, but commonly they are towed by the oyster sloops if the wind is light.

When the oysters arrive at the shipping point they are transferred to large cars anchored near the dock, and are also put in bins under the wharves. These bins are so arranged that the water covers the oysters at full flood and uncovers at low tide. Oysters are shipped to supply orders, and are sent to market in sacks holding about 100 pounds each.

The sloop boats employed in the fishery take the catch to the southern end of the bay, where it is transferred by team overland to Ilwaco, on the Columbia River, a distance of about 7 miles. Here it is placed on the steamer for Astoria, whence it is reshipped to Portland, San Francisco, and other points. There is a railroad between Ilwaco and a point about 3 miles south of Oysterville. Were it not for the large freight charges over this line the products of the oyster fishery could well reach market in a much less time than is required at present. The fishermen find, however, that the few hours gained by the latter method are not sufficient to compensate for the additional expense.

Salmon canning.—There were four salmon-canning establishments located on Shoalwater Bay and its tributaries in 1888: One at the mouth of North River; one 8 miles inland from the mouth of the Whilapah River; another at Bay Center on the Palux River; and the fourth at the southern extremity of Long Island. The last-mentioned establishment was idle in 1888, although operated in 1887. The three canneries packed 22,500 cases in 1888.

The statistics of the fishery industry of Shoalwater Bay in 1888 are as follows:

Persons employed.

Country.	Fishermen.		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	144	168	15	15
United States (Indians)	113	113		
Russia	19	9		
Sweden	17	8		
China			110	110
Norway	2			
Germany	3			
	298	298	125	125

Apparatus and capital.

Designation.	No.	Value.
Boats	187	$19,415
Pound nets	42	22,000
Gill nets	108	11,850
Oyster tongs	175	875
Shore property		*58,000
Cash capital		55,000
Total		167,140

* Including $12,000, the value of a salmon cannery temporarily idle in 1888.

Products.

Species.	Quantity.	Value.
Salmon ....pounds..	1,755,000	$52,650
Oysters........do....	3,276,200	65,524
Total	5,031,200	118,174
Salmon canned ....cases..	22,500	129,375

47. FISHERIES OF GRAY'S HARBOR AND CHEHALIS RIVER.

Gray's Harbor is located between 46° 02′ and 47° 02′ north latitude, and 123° 50′ and 124° 10′ west longitude. It is the second largest bay on the coast northward from Cape Disappointment, and affords an excellent harbor. Unlike Shoalwater Bay, it receives quite a large river (Chehalis), the main and eastern branch of which has its source in the westernmost flank of the Cascade Range, while another tributary rises near Olympia, at the head of Puget Sound. There are several smaller branches which stretch behind Shoalwater Bay and reach within 12 miles of the Columbia River.

The harbor is divided into two parts, known as North and South Bays. John's Bay is a small body of water inclosed on the west and south by a sand spit which forms Point Brown, the northern headland of the bay. The Chehalis River empties into the harbor directly east from the entrance of the bay. In addition to the Chehalis there are the Neuskahl, John's, and Elk Rivers on the south shore, and Kishkah, Hoquiam, and Humptulupus Rivers, and Chenois Creek on the north side.

Until recently the harbor was of little importance commercially, and attracted but slight attention. At present, however, it is coming into prominence and many new towns are being located on the shores of the harbor and Chehalis River, among which may be mentioned Hoquiam, a village of several hundred inhabitants at the mouth of the river; Aberdeen, 2 miles above, with 1,300 people; and Montesano, 13 miles up the Chehalis River, with a population of 1,500. Each of these has practically sprung into existence in the last 5 years, the rapid growth of the region being due to the stimulating influences of existing and projected lines of steamboats and railroads.

Fishing centers.—There are no fishing centers of importance on the bay. Aberdeen is, perhaps, the principal center, because of the location of two canneries there, and Montesano has one canning establishment. But while neither has attained marked prominence, they doubtless have important possibilities for the future.

Importance of the fisheries.—There is no commercial fishing in this region except during August, September, October, and November, when salmon are captured to supply the packing establishments. Aside from salmon, the only fishery interests are those maintained on a small

SALMON
CHEHA
46°
55'
45'
40'


U. S. Commission of Fish and Fisheries
Marshall McDonald, Commissioner
CHART SHOWING THE FISHERIES IN GRAY'S HARBOR AND CHEHALIS RIVER
STATE OF WASHINGTON.
— SEASON OF 1889. —
Pound-nets represented thus ⟶
2 POUND-NETS
NORTH BAY
SOUTH BAY
RAZOR CLAMS
(Siliqua patula)
SOFT CLAMS
(Mya arenaria)
Point New
Typso Cr
Hoquiam
Hoquiam R
Aberdeen
CANNERIES
CANNERY
Montesano
SALMON GILL-NET FISHING ABERDEEN TO MONTESANO
CHEHALIS RIVER
Point Brown
Johns Bay
Markham
Johns River
Bay City
Elk River
Point Chehalis
Humptulips R
Wishkah R
Newskah R
124° 10
124° 00
123° 50
123° 40

scale by a few straggling Indians, who occasionally bring fish into the villages: but the variety and abundance of fish, and the fast-growing towns not far distant afford a prospective opportunity to establish a profitable fish trade.

Species, seasons, etc.—Three varieties of salmon frequent Gray's Harbor, the quinnat, silver, and steelhead. The quinnat salmon is present from July until October; the silver from about the middle of September until November, and the steelhead from December until May. In addition to salmon, there are salmon trout, mountain trout, perch, tomcod, sturgeon, sardines, and several species of the *Catostomidæ*. On the banks outside the harbor are caught orange rock-cod (*Sebastichthys pinniger*), red rock-cod (*S. ruber*), halibut, etc. Two varieties of shellfish are also very abundant on the mud flats—the eastern soft-shell clam (*Mya arenaria*) and the razor clam (*Siliqua patula*).

Fishing grounds.—The gill-net grounds are mostly in the various channels of the bay and in the river. Pound nets are located at several points, the greatest number being along the river between Aberdeen and Montesano. The deep-sea banks are located outside the harbor heads about 10 miles offshore, in a northwesterly direction from the whistling buoy off the entrance.

Capt. John Reed reported that often when waiting outside the harbor, to tow vessels in, on or near the fishing bank, he has caught a fine lot of fish. Frequently halibut are taken, and on one occasion 22 were caught in a few hours' fishing with hand lines over the rail; the largest weighed 87 pounds. There is a depth of 30 fathoms of water on the bank, with a gravelly and rocky bottom.

Soft clams are found in abundance on beds on both sides of the river's mouth west of Hoquiam. Razor clams occur in the mud flats in North and South Bays.

Fishermen, etc.—In the fall a number of fishermen from the Columbia River go to the Chehalis to fish for the canneries there. The gill-net fishermen of the river are mostly foreigners, but the men who tend the pound nets are chiefly Americans.

Apparatus and boats.—The apparatus employed in the fisheries of Gray's Harbor consists of pound nets and drift gill nets. Owing to the fact that the early run of salmon in the harbor and river is composed of individual fish of nearly double the size of those constituting the fall run, two kinds of nets are required. Pound nets of a very expensive type are in use on the Chehalis River. Their average value in 1888 was $700. The number employed that year was 37, so that the capital invested in pound nets alone was nearly $26,000. Two kinds of boats are employed in the fisheries. The majority are of the flat-bottomed, sharpy type; a few of the Columbia River salmon-boat style are also used.

Disposition of the products.—All the salmon captured in the bay and river in gill nets and pounds are utilized at the packing establishments

for canning purposes. Other species are not sought. There is some desultory fishing by Indians.

Salmon canning.—There are four canning establishments located on the river: Two at Aberdeen, one a few miles above that town, and the fourth at Montesano. In 1888 the four factories gave employment to 176 factory hands and utilized 2,775,000 pounds of fresh salmon, valued at $83,250, the canned product aggregating 37,000 cases.

The following tables exhibit the extent of the fisheries of this region in 1888:

Persons employed.

Country.	Fishermen.		Factorymen.	
	Nativity.	Nationality.	Nativity.	Nationality.
United States	105	152	21	21
United States (Indians)	15	15		
Norway	12	9		
Russia	62	39		
Sweden	42	21		
China			155	155
Total	236	236	176	176

Apparatus and capital.

Designation.	No.	Value.
Boats	85	$10,125
Pound nets	37	25,900
Gill nets	170	23,375
Shore property		44,000
Cash capital		70,000
Total		173,400

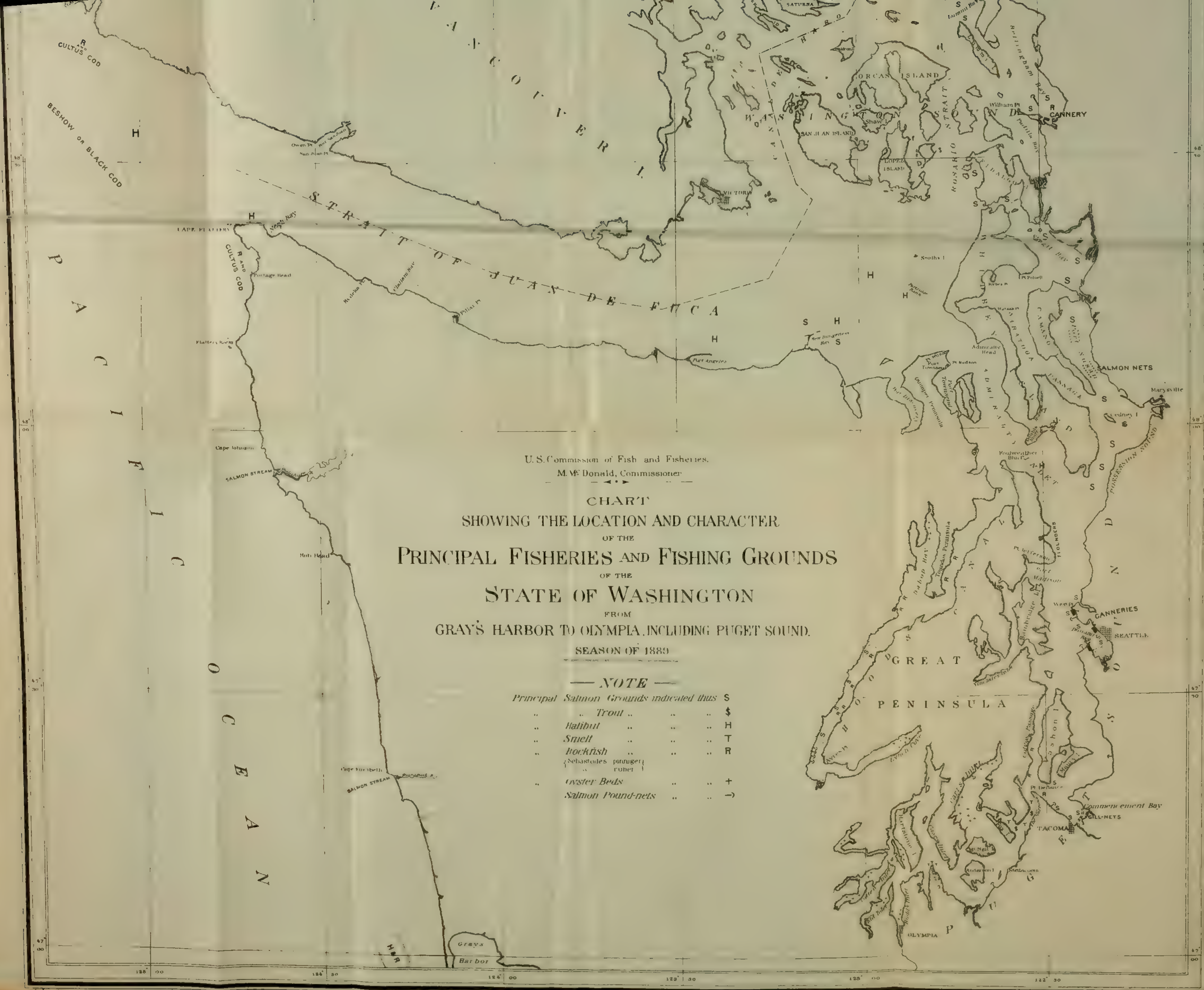
Products and values.

Species.	Quantity.	Value.
Salmon ... pounds	2,775,000	$83,250
Salmon, packed ... cases	37,000	212,750
Total		296,000

48. FISHERIES OF THE QUINIAULT RIVER.

This small stream is in Chehalis County, and empties into the Pacific 3 miles northwest from Point Grenville and 1 mile east of Cape Elizabeth. It abounds in salmon of several varieties which begin to run in January and continue until the latter part of November. The first run is said to be that of the quinnat salmon, but it is more than probable that the species is the blueback (*O. nerka*). The salmon which appear in the fall are known as the "black salmon," which, on account of their size, are thought to be the quinnat.

The river is included within the precincts of the Quiniault Indian


U.S. Commission of Fish and Fisheries.
M. McDonald, Commissioner
CHART
SHOWING THE LOCATION AND CHARACTER
OF THE
PRINCIPAL FISHERIES AND FISHING GROUNDS
OF THE
STATE OF WASHINGTON
FROM
GRAY'S HARBOR TO OLYMPIA, INCLUDING PUGET SOUND.
SEASON OF 1889
NOTE
Principal Salmon Grounds indicated thus S
.. Trout .. .. .. $
.. Halibut .. .. .. H
.. Smelt .. .. .. T
.. Rockfish .. .. .. R
(Sebastodes pinniger, ruber)
.. Oyster Beds .. .. +
Salmon Pound-nets .. .. —)
PACIFIC OCEAN
VANCOUVER I.
STRAIT OF JUAN DE FUCA
CULTUS COD
BESHOW OR BLACK COD
CAPE FLATTERY
R AND CULTUS COD
SALMON STREAM
Cape Johnson
Flattery Rocks
Port Angeles
ORCAS ISLAND
SAN JUAN ISLAND
LOPEZ ISLAND
VICTORIA
WASHINGTON SOUND
ROSARIO STRAIT
CANNERY
SALMON NETS
Marysville
POSSESSION SOUND
Admiralty Head
ADMIRALTY INLET
Foulweather Bluff
CANNERIES
SEATTLE
GREAT PENINSULA
Commencement Bay
GILL-NETS
TACOMA
OLYMPIA
PUGET SOUND
Grays Harbor
H&R

Reservation, and, although attempts have been made to locate canneries on it, none but Indians are permitted to fish in the river; they catch a large quantity of salmon and prepare them for winter use. In 1888 there were about 300 men, women, and children on the reservation.

Sea otters were abundant near the mouth of the river in early days, but they have been hunted nearly to extermination.

49. FISHERIES OF THE QUILLIHUTE RIVER.

The Quillihute River is located in Clallam County within the limits of the Quillihute Indian Reserve. Its length is about 30 miles. There is a run of salmon from August to November, from which the Indians derive their principal article of food for the winter. In 1888 there was a population of 252 Indians living on the reservation. These Indians also engage in whaling during the summer; nine finback whales were captured in 1888; these were cut up and smoked for food. The catch is wholly for home consumption and has no commercial importance.

50. FISHERIES OF PUGET SOUND AND VICINITY, INCLUDING THE STRAIT OF JUAN DE FUCA.*

Geographical features.—From the standpoint of the fisheries, this region seems to have exceptional geographical advantages. The broad, deep Strait of Juan de Fuca, which separates the northwestern part of the State of Washington from Vancouver Island, affords an excellent entrance from the Pacific to Puget Sound and Washington Sound, as well as to the Gulf of Georgia, of which there is only a small portion within the boundary of the United States. At the western extremity of the strait, on the Washington side, is Cape Flattery; from this to near the entrance to Puget Sound the land is generally bold and high, with stretches of low, sandy beaches or long spits, but, except at Port Angeles, there are no fairly well-sheltered and safe harbors.

Puget Sound is one of the most remarkable waterways in the United States. Its deep and well-sheltered channels extend long distances inland, winding around many peninsulas and among numerous islands of greater or less extent (one of the latter being 30 or more miles in length), thus affording easy communication to an immense coast area. There is no lack of good harbors where fishing fleets may lie in safety, and also where curing and packing houses may be established whenever occasion calls for it. This region is comparatively near the Alaskan fishing grounds, and important halibut banks are in the vicinity. The towns on the sound are rapidly growing in population and importance, and considering the present transportation facilities and the probable extension of railroad communication in the near future, this is a specially

* Reference is made to the map, plate XLIII, for a clear understanding of this region, so far as the configuration of the coast and the extent of Puget Sound and adjacent waters are concerned.

favored region for prosecuting the sea fisheries of the Pacific. Indeed, Puget Sound, Washington Sound, and the Strait of Juan de Fuca are valuable fishing grounds, which will be referred to at greater length elsewhere.

The channels and harbors of Puget Sound are generally deep and unobstructed; but in some sections at the head of the sound, notably at Olympia, Commencement Bay, Nisqually Beach, and a few other places, the water is generally shallow, and in some cases navigation is impracticable near the shore except by small boats or flat light draft vessels. It is not uncommon for large areas of shallow flats to uncover at low tide. The land is much diversified in appearance. As a rule, it is high and broken, with ranges of mountains and several high peaks a short distance from the coast. Along the shores, however, are broad stretches of gently rising plateaus. The islands are generally rather low, but in many places the coast is fringed with low hills, varied by small valleys and frequently with steep headlands next the water.

Fishing centers.—The fishing centers of this region, mentioned in the order of their importance as such, are Seattle, Port Townsend, Tacoma, Neah Bay, Dungeness, and Olympia.

Seattle is a city of about 30,000 inhabitants. It is largely interested in maritime commerce, especially in the coal and lumber trade, and is the most important fishing center on Puget Sound. In 1888 it had a fishing fleet of six vessels (all schooners), with an aggregate tonnage of 426.36, engaged in pelagic sealing. Two schooners from Gloucester, Massachusetts (the *Mollie Adams* and the *Edward E. Webster*), which, in addition to pelagic sealing, were engaged a portion of each season in halibut fishing, made their headquarters here in 1888 and 1889. In the latter year a San Francisco vessel was chartered by Seattle parties and employed in the halibut fishery. In addition to sea fisheries, Seattle has important interests in the salmon industry. Besides the canning of salmon, it is the principal shipping point of the region for frozen salmon that are sent East by rail. The market fishery of Seattle is of much less consequence than might be expected, taking into consideration the advantages for catching fish, the growth of the city, and the facilities for shipments.

Port Townsend is a thriving town, with an estimated population of 5,000 or 6,000. It is situated near the junction of the Strait of Juan de Fuca with Puget Sound, and for this reason has been termed the "Key City." So far as the proximity of the sea-fishing grounds is concerned, it is somewhat more favorably situated than Seattle, but it lacks the railroad facilities of the latter, and is to that extent at a disadvantage as a fishing port. It has an excellent harbor, and doubtless will soon have railroad communication with the interior.

The fisheries of Port Townsend are yet confined to a limited amount of pelagic fur-sealing and some boat and shore fishing to supply the local market. In addition to this, one New England schooner (the

Oscar and Hattie, of Swampscott, Massachusetts), which engaged in the salt and fresh halibut fishery, made its headquarters there in 1889.

Tacoma is an important railroad terminus, of 25,000 inhabitants, situated about 20 miles south of Seattle, near the head of Puget Sound. It is largely interested in general commercial pursuits, among which lumber and shipping take precedence. The fishing interests are of considerable importance, and a large variety of fish is shipped from here to supply towns in the interior.

Neah Bay is located near Cape Flattery. Here there is an Indian reservation for the Makah tribe, which had a population of 484 in 1889. The Indians depend almost entirely upon the fisheries for a livelihood. Three small vessels, aggregating 80.57 tons, fished from Neah Bay in 1888, and there was another which was idle during that season, but employed the following year. All these were engaged in pelagic fur-sealing. The place is noted for the large number of dugout canoes employed in the fisheries, over 200 being owned there at the time Wilcox visited the bay. There are also curing houses, which will be referred to elsewhere.

Dungeness is located 17 miles west of Port Townsend; the harbor is poor and the place is of no great importance. A few Indians live in the vicinity and catch salmon chiefly for their own use. One small schooner of 49.62 tons made the place its headquarters while engaged in the fur-seal fishery in 1888.

Olympia, the capital of Washington, is at the head of steam navigation at the southern extremity of Puget Sound. It is chiefly engaged in manufacturing enterprises; its fishing interests are inconsiderable, consisting of clams dug for local use and a small oyster fishery.

Fishermen, factory hands, lay, etc.—A large majority of the fishermen are engaged in the coast or shore fishery. They are very cosmopolitan, representing eleven countries in addition to Indians. In 1888 there were 917 fishermen, of which 287 owed allegiance to the United States, in addition to 434 Indians of the Makah tribe. Among the white fishermen classed as citizens of the United States are those fishing from Puget Sound on vessels owned in New England, but which for the time being were a part of the fleets sailing from Seattle and Port Townsend. The personnel of the canning factories of Puget Sound is essentially the same as that on the Columbia River; a few white men are employed for superintendents, but the majority of the operatives are Chinese. Reference is made to the lay, wages, etc., under the heads of the different fisheries.

Species, abundance, seasons, etc.—Whales, chiefly the small sharp-head finner (*Balænoptera davidsoni* Scammon) are found off Cape Flattery and at the entrance of the Strait of Juan de Fuca, where the Indians improve every opportunity to capture them.

The fur seal (*Callorhinus ursinus* Linn.) is one of the most important objects of the fisheries of Puget Sound. It arrives off Cape Flattery in

the spring, and is followed from there, in its migrations northward, until it reaches the waters of Bering Sea. The fur-sealing season was formerly from early in March (or possibly in February) until June; it is now continued much later. The sea otter is occasionally taken by the crews of the sealers.

Flounders of several varieties occur in the waters of Puget Sound and vicinity; they can be taken at all seasons, and constitute quite an important item in the fish trade at Seattle. The largest species is *P. stellatus* Girard, which is common and abundant in the vicinity of Cape Flattery and Neah Bay during summer. "The other varieties are known by the common names of large-eyed flounder, large-scaled flounder, hook-toothed flounder, long-finned flounder, short-finned flounder, bastard turbot, spine-cheeked turbot, black-tailed sole, black-dotted plaice, and other varieties of the small flounder family which are sold as sole. * * * They are very plentiful, and are readily taken with trawl nets, so that a supply can be had at any time."*

The halibut (*H. hippoglossus*) is, next to salmon, the most important species of fish in this section. During a large part of the summer season it is abundant in the vicinity of Cape Flattery, but frequently has to be sought at a more distant locality.

Cod (*Gadus morrhua*) and cultus-cod (*Ophiodon*), which is most commonly called "cod" here, occur in various parts of the sound and strait. They are reported to be most plentiful in February and March.

Herring occur at all seasons of the year, and are generally abundant. In a letter written to Professor Baird by J. P. Hammond and published in the American Angler, December 18, 1886, the following statement is made:

> From 1869 to 1877 it was not an uncommon occurrence for us to catch from 200 to 300 barrels of herring in a night, but since 1877 they have been growing less in number, until now the largest night's work is about 20 barrels.

The big red sculpin (*Scorpænichthys marmoratus*) is also called "rock-cod" by the fishermen. It occasionally attains a weight of 10 or 12 pounds, and is considered a good food-fish.

Rockfish of various species, mostly of the genus *Sebastichthys*, occur at all seasons. There are nearly the same varieties of rockfish here as at San Francisco, and they need not be discussed in this connection.

The black bass (*S. melanops*) is taken chiefly during July and August in the vicinity of Tacoma.

Perch (*Damalichthys*) and tomcod (*Microgadus*) occur at all seasons and are often abundant; but the latter species is not an object of capture.

Here, as at many other points on the Pacific coast, the salmon is the principal object of fishery. The following are the most important species taken in Puget Sound: Humpback (*O. gorbuscha*), silver (*O.*

---

* James G. Swan, in Portland (Oregon) Journal of Commerce, November 15, 1884.

kisutch), and "jack" or "tyee" (*O. chouicha*), which is the quinnat or king salmon of California, and the Chinook of the Columbia. The red salmon (*O. nerka*), called the "sockeye" here, is the most abundant species at the northern part of this region, where also the steelhead occurs in small numbers, according to Mr. W. H. Kirby.

The jack salmon is the first to appear each season. It begins to run about the middle of August and remains in these waters until October, appearing singly or in schools. Its average weight is 11 pounds. It is stated that on some of the rivers of this region, particularly the Skagit, this species will average 20 pounds in weight, while the maximum often reaches 50 pounds.

The silver salmon does not arrive before September, and usually remains until about the first week in November. Its average weight is about 7½ pounds.

The humpback salmon, or "haddoh," is found from July 15 to August 15. This species is not very abundant, and is comparatively unimportant from a commercial standpoint.

The sockeye "run" is usually from early in July to September.

The dog salmon (*O. keta*) comes in the fall. It is not commercially important, for it has not yet been considered suitable for canning, and there is no market demand for it. But the Indians prefer it for drying, and depend almost entirely upon this species for their supply of salmon cured in this way. Other species, particularly the quinnat or "jack" salmon, are too fat for drying satisfactorily, and can not usually be dried whole like *O. keta*.

The presence of salmon in the sound is generally indicated by their jumping, but this does not always signify that they are numerous enough to warrant the use of a seine. The presence of large schools is more certainly determined by observing the fins showing above the water.*

Captain Tanner states that—

> A Mr. Herrick, formerly connected with a cannery on Columbia River, but now in the employ of Parker & Felters at Seattle, claims from an experience extending over the past 20 years that salmon are rapidly decreasing in this region. This decrease is due not only to the great annual catch, but also to the presence of much floating refuse from the sawmills of the neighborhood. Mr. Myers, of the Dwamish Head Cannery, on the contrary, considers that there has been no general decrease, and that there are no indications of the salmon becoming exterminated as some predict. He has been connected with the fishery in Puget Sound for the past 12 years, and states that salmon are as abundant now as at any time in the past. They fluctuate in abundance, however, from year to year. (*Albatross* Explorations.)

Smelt occur throughout the year, and are often very abundant.

A few shad are occasionally taken in Mud Bay, in the vicinity of Olympia, by the Tacoma fishermen. They were first noticed in Puget Sound in 1884, since which time they appear to have slowly increased in

* When a school of salmon come near the surface, so that their fins can be seen, the fishermen say that they are "finning."

numbers, although the catch is yet unimportant, probably because no systematic efforts are made with proper apparatus. The fishermen in this region have undoubtedly been wise in refraining from making any special attempt to capture shad, since the species is thus afforded an opportunity to multiply, which it otherwise might be prevented from doing. They run in spring and summer. The average weight of those taken at Tacoma was 4½ pounds, although individuals have been obtained which weighed 6½ pounds.

Salmon trout occur about the head of Puget Sound in the vicinity of Olympia. Off Johnson Point and near Tacoma are noted fishing grounds for them. Considerable quantities are taken for the market.

Sardines (*C. sagax*) occur here in the warmer part of the season, and are taken with herring and other species for market. An effort will probably soon be made to can sardines here as at San Francisco.

Dogfish (*S. acanthias*) are rather plentiful. A considerable number are taken for oil. Hammond claims, however, that this species "has become entirely extinct on some of the old fishing grounds, and on many others where a man with 500 hooks would take from 300 to 500 dogfish in a night he would not take that many in an entire season now."

The black-cod (*A. fimbria*) is said to be numerous in deep water in the Strait of Juan de Fuca. It is only obtained incidentally and is not an object of commercial fishery.

Crabs are not abundant but are taken to a moderate extent for local consumption. Shrimp are plentiful, but only a few are caught. Clams of several varieties occur at the head of the Sound, where they are taken in considerable quantities. There are four varieties of clams: *Schizothœrus nuttalli;* giant clam, *Glycimeris generosa;* common round clam, *Tapes staminea;* and long clam, *Mya arenaria.*

Swan says that "the cockle, '*Cardium corbis*,' is very plentiful, and is dried by the Indians in great quantities for their winter use and to sell to the tribes of the interior." It may be said that at the present time the cockle is not of any commercial importance.

Native oysters occur most abundantly at the head of the Sound, in the coves, and on the flat, shallow reaches, many of which uncover at low tide. These are native beds. The oysters are small and dark-colored and have the characteristic coppery flavor.

THE MARKET FISHERIES.

The fisheries prosecuted from ports on Puget Sound for the purpose of supplying the inhabitants with fresh fish have not yet reached that state of development and importance that warrants a very lengthy discussion in these pages. As the coast cities and towns gradually pass from infancy into maturer years and become possessed of stable populations and more intimate relations with interior towns, the demand for fish food will no doubt become more and more pronounced, and efforts will then be directed towards the market fisheries. Up to the present

time, however, the rapid growth of the Northwest has put such a premium on skilled and unskilled labor that there has been no necessity and little incentive for men to engage in the arduous and hazardous calling of fishing. Wilcox has observed that among the public buildings which spring up when a new town is established a good substantial fish market is usually not among them, and small shanties near the water's edge are generally the inauspicious pioneers of the market fisheries in all the settlements on Puget Sound.

Port Townsend is at most seasons fairly well supplied with fresh fish by a small fleet of sloop-rigged boats manned by about 40 persons. The species exposed for sale are mostly halibut, taken near the Strait of Fuca, and salmon, rockfish, black-cod, etc., secured in the waters of the Sound. The Indians at Neah Bay also contribute at times to the market supply of Port Townsend. The market fisheries of Seattle, although surpassing in extent those of all the other towns on the Sound combined, are not commensurate with other industries or the needs of the city. The principal varieties marketed fresh are rockfish, flounders, herring, perch, smelt, sardines, and salmon, of which about 1,150,000 pounds, valued at $42,000, were taken in 1888.

Tacoma represents about the southernmost point on the Sound from which market fishing is carried on and at which salt-water fish occur. Adjacent to the city, shad and salmon trout, in addition to the species already mentioned, are taken in pound nets, gill nets, and seines, operated from small sloops and open boats. The total catch in 1888 was over 850,000 pounds, worth to the fishermen $32,570. The market fisheries of this city are no doubt greatly promoted by a well-kept market with refrigerators, and by the abundance of ice used in preserving the properly dressed fish.

Market prices.—The following is a list of market prices for fishery products obtained at Tacoma, and these apply, with certain minor modifications, to other places on Puget Sound:

Species.	Unit.	Average prices.
Salmon	Pound	$0.03
Salmon trout	do	.08
Cod	do	.05
Rockfish	do	.03
Smelt	do	.03
Perch	do	.03
Halibut	do	.05
Shad	do	.25
Shrimp	do	.10
Crabs	Number (each)	.10
Clams	Sack (100 pounds)	1.00
Oysters	do	2.50
Oil	Gallon	.40

Fishing grounds.—Reference is made to the map, plate XLIII, for the location of the fishing grounds in this region. Halibut, cultus-cod, rockfish, and black-cod can be taken on numerous spots, indicated on the

map, from off Cape Flattery and Cape Beall (Vancouver Island), in the Strait of Juan de Fuca and in Puget Sound.

Captain Tanner makes the following reference to the halibut grounds resorted to by vessels from Puget Sound ports:

> The nearest bank to Puget Sound, where halibut are abundant, is located off Cape Flattery at the mouth of the Straits of Fuca, and extends from close inshore to some 12 or 15 miles off the cape, in depths of water ranging from 35 to 75 fathoms. From early in the spring until the middle of June halibut can be obtained on these grounds in paying quantities, but later in the season dogfish and sharks strike in, driving nearly all the edible fish away. During the summer more northern localities would have to be resorted to. This information is based upon the statements of Capt. Silas Calder, commanding the schooner *Mollie Adams*, and at the time this region was examined by the *Albatross* the dogfish were found in full possession of all the important grounds.

Alexander thinks that the abundance of halibut, and the importance of the fishing grounds where this species can be taken have been overestimated. While he believes it possible that halibut may occasionally be found in great abundance, the researches of the *Albatross* have not led to the conclusion that they are generally very numerous. Scattering halibut were found about Middleton Island, the Shumagin Group, and Kodiak, but there was nothing to justify the belief that vessels could easily obtain fares at either of these places. The vessels engaged in the halibut fishery that have made their headquarters at Puget Sound ports have extended their cruises to more distant grounds, in many instances going as far as Alaska.

The principal grounds for salmon and rockfish are in Puget Sound and Washington Sound. The location is indicated on the map by the letters "S" and "R." The most important fishing grounds for trout and smelt are in the southern section of Puget Sound. The grounds resorted to for pelagic fur-sealing are the same as have been mentioned in connection with the fisheries of San Francisco.

It can scarcely be said that there are now any whaling grounds. Whales are rarely taken, and then only incidentally by the Indians and never for commercial purposes.

THE FUR-SEAL AND SEA-OTTER FISHERIES.

Among the sea-fishing enterprises carried on from Puget Sound, pelagic fur-sealing has attracted considerable attention of late, both because of the financial hazard involved (for few fisheries are more uncertain as to results) and the fact that vessels, catch, and all have sometimes been placed in jeopardy by the fishermen venturing to push their hunt into the waters of Bering Sea, from which they were excluded by law. Sometimes a "lucky" vessel has secured large returns for the capital invested and time employed, but quite as often the financial results have not been very profitable. However, the hope of being the "lucky one" tempts many to engage in the business from

year to year; while others have followed this fishery so long that they have nothing better to do, and each season finds them starting out on a voyage as a matter of course.

Pelagic sealing has been carried on for some years from the Puget Sound region. As early as 1880 Swan records the fact that six schooners had been employed in seal fishing from Neah Bay during the previous year. These were the *Endora*, of San Francisco, and the *Champion*, *Teaser*, *Lottie*, *Letitia*, and *Mist*, of Port Townsend. The fishery has been prosecuted with varying fortunes since that time.

From the first the Makah Indians have been active participators in this industry, and that tribe furnishes some of the most skillful hunters employed in the business—men who have both an inherited and acquired knowledge of the pelagic habits and movements of fur seals. In recent years white men have entered more extensively into the seal hunt, and their numbers were materially augmented in the summers of 1888 and 1889, when the schooners *Mollie Adams*, *Edward E. Webster*, and *Henry Dennis* came here from New England, and brought large crews and an elaborate equipment of boats, etc., to engage in pelagic sealing. Although these vessels hailed from ports on the Atlantic, they really became a part of the fleet of this region, and have been so considered here. It would be interesting to trace in detail the history of this branch of the fishery, but its importance scarcely seems to demand it, and space will not permit it.

Vessels and boats.—With the exception of the before-mentioned New England schooners, the vessels employed in the seal fishery from Puget Sound and vicinity are small, roughly constructed, cheap craft, such as would scarcely command crews from many of the Atlantic ports.* It was stated before the Senate committee that vessels fitted out for the sealing business cost from $600 to $1,800, and $2,000 are required to fit one out. The vessels are all schooner-rigged and carry large crews and many boats. The boats are chiefly of two types, one introduced by the New England fishermen and the other a native dugout canoe.

Apparatus and methods of fishing.—The following account of the apparatus and methods employed by the Indians was prepared by Swan in 1880, and, with few minor changes, among which the use of firearms is the most noticeable, is said to be applicable to the present time:

Until within a few years past the Indians have gone to sea boldly in their canoes, starting out at daybreak and returning at night. Three men usually go in a canoe at such times. Latterly they have put their canoes on board the sealing schooners which take them to the sealing grounds and lie by while the Indians go off in them and spear seals; the canoes taken on board the schooners had but two Indians in each.

The outfit of each canoe consists of one and sometimes two spears, which are fitted

* Captain Joshua Brown testified before the Senate Committee on Relations with Canada (see page 344) as follows: "I have not seen a vessel here that you could get a crew upon from Gloucester to do the fishing. There is very little value to those soft-wood vessels. They are coarse and rough."

in the following manner: A pole 15 or 16 feet long, with a broad place at one end, on which the fingers are clasped, and fitted with two prongs at the other end, which are inserted into the sockets of two barbed spear-heads, each attached to a stout line either made fast to the pole near the middle or held in the hand of the spearsman. A club is also provided for knocking the seal on the head after he is speared; and two buoys made of the skin of the hair seal (*Phoca pealii* Gill), taken off whole and blown up with the hair side in. These buoys are used either to bend on to the spear line if the animal is not easily killed, or in case of rough weather they are attached to each side of the canoe a little forward of the center, and render her steady and seaworthy.

After a strong wind and the accompanying heavy sea have subsided, the seals lie on their backs in the water and sleep. Then the Indians cautiously and quietly approach them, and, selecting a victim, silently paddle near enough to thrust the spear deeply into its body, and at once withdrawing the pole leave the barbs imbedded in the flesh, sometimes killing it outright, but oftener only wounding it. The barbed spearhead, however, holds fast, the line is quickly hauled in and the seal knocked in the head with a club. They smash in every seal's head, whether it has been killed by the spear or not, and so universal is this practice that, although I have repeatedly offered to pay the Indians liberally for a perfect skull, I have been unable to procure a single specimen. The Indians here never use firearms to kill seals; they say the report would scare them away, and they strongly object to white men using rifles on the sealing grounds.

After the day's hunting is over, the canoes which have put off from the shore return with the seals they have taken, which are then skinned on the beach or in the lodges by the women. The canoes belonging to the schooners take their catch on board the vessels which at first brought them all ashore to be skinned, but this season they have been mostly skinned and salted on the schooners. Each vessel takes as many canoes as she can carry, the number varying according to the size of the vessel, from eight to fifteen being the average, although the largest vessels can take twenty, but very seldom exceed fifteen. The Indians pay one-third of their catch for having themselves and their canoes transported to the sealing grounds and back to Neah Bay.

These schooners have cabin accommodations for the officers and crews, and the Indians are assigned quarters in the hold among the salted skins, reeking carcasses, and blubber of the seals, for the Indians wish to save the blubber to make oil, and the carcasses to use for food, until they are too plentiful, when they are thrown overboard, or, if skinned on shore, left on the beach for the tide to remove.

The largest of the schooners have forecastle accomodations for some of the Indians, but the most of them sleep in the hold, where the peculiar odor of the seal skins and blubber seems to impart a healthy and invigorating influence on these savages, who appear to thrive and grow fat during the season.

The blubber taken from the seals is tried out by the women in the lodges; they cut it into small pieces, which they boil in iron pots and brass kettles. The oil when cold is put into various receptacles, generally into large pouches or bottles made from the paunches of seals, sea lions, or the killer (*Orca ater* Cope), which abounds in Fuca Strait. These pouches are first cleaned, then blown up full of wind and rolled and rubbed and stretched, and again and again blown up till they attain their utmost tension. They are then left to dry, in which condition they retain their shape and are serviceable in holding oil.

The cleanest and nicest oil is placed in these paunches and is used with their food as white people use sweet oil or butter, and when fresh is no more disagreeable than lard. Oil that gets scorched or dirty, or any surplus oil, is sold to the whites.*

* From testimony taken by the Select Committee on Relations with Canada, Senate Report 1530, part 1, Fifty-first Congress, first session, page 272.

The apparatus and methods employed by the white seal-hunters are essentially the same as those referred to under the head of the fur-seal fishery from San Francisco.

Review of the fur-seal and sea-otter fisheries, 1888.—The following review of the pelagic seal and sea-otter fisheries prosecuted from the various ports of this region is arranged to show the interest of each place during the season of 1888. When the investigation closed upon which this report is based the season of 1889 was not completed.

The business of taking fur seals and sea otters was prosecuted from Dungeness, Seattle, Port Townsend, and Neah Bay in 1888.

One vessel, the schooner *Granger* (49.62 tons), engaged in pelagic fur-sealing from Dungeness. The vessel carried 3 white men and 18 Indians, in addition to 2 squaws employed in dressing the skins. Its outfit included 9 Indian canoes, and guns and spears. The result of the season's work was 510 sealskins, valued at $2,550. The lay, which differed somewhat from that in other fishing centers, was as follows: The Indians received $1.15 for each seal secured; the captain was paid a salary of $75 per month, and the other white men were also on salaries, at $40 per month.

Three vessels, aggregating 129.24 tons, made Port Townsend their headquarters while engaged in this fishery. One of these also devoted some attention to the pursuit of sea otters. The season's work resulted in the capture of 1,040 seals and 30 sea otters, valued at $5,825 and $3,450, respectively. The seal-hunters from this place received $2 for each seal recovered, and the boat-pullers got 50 cents a pelt. The masters of the vessels were paid regular wages, and also a commission on the gross stock. The cooks got 50 cents a skin.

For a number of years a few small vessels have followed fur-sealing from Seattle with varying success. Recently larger vessels from Gloucester, Massachusetts, have entered into the business, and in 1888 the fleet consisted of 5 sail, with an aggregate tonnage of 341.45. The seals are all taken outside of Puget Sound, on the high seas. The vessels go south in the spring, and usually fall in with seals in the vicinity of the Farallone Islands. They then follow the animals as they migrate north. The season lasts from April to October, during which time, if fishing is good, vessels in this fishery will make several trips, landing their fares at Port Townsend, Seattle, or Victoria, refitting and again following the seals toward the north. The crews consist of 18 to 29 men, and are divided into boat-pullers and hunters, one man of each class going in a boat. The boat-pullers receive $25 a month and a bonus of 10 cents for each seal secured by the boats, while the hunters are paid $1.50 for each seal taken. White men constituting the crews use only guns in the capture of seals, while the Indians employ both guns and spears. One vessel, in 1888, was fitted out with three large gill nets for capturing seals; these had a total length of 350 fathoms, were 3 fathoms deep, and had a 10-inch mesh. The vessel

lost 2 men. The nets were not considered a success, only 337 seals being secured, while the average catch of the other vessels of the fleet was over 550 seals. The total catch in 1888 was 2,551 seals, valued at $15,158.

Three vessels, with a total net tonnage of 80.56, made Neah Bay their home port while fur-sealing in 1888, and another vessel also engaged in the fishery the following year, but was seized for illegal sealing. The crews of the vessels from this place are almost entirely Indians, and the vessels are really owned by them, but a few white men are shipped to manage the craft and comply with the customs regulation requiring the master to be a citizen of the United States. There were 1,250 seals taken in 1888, yielding $5,925.

THE SALMON FISHERY.

Importance.—The salmon fishery is the most important one carried on in the waters of Puget Sound, and the catch amounts to more than a third of the entire yield of fish in this region. Salmon are taken in considerable quantities at Seattle, Port Townsend, and Tacoma; small quantities are also secured by the Indians of Neah Bay. The salmon fishery at Seattle is more prominent than that for all other species combined, and owes its importance to the canneries at or near that place.

Apparatus and methods of capture, yield, etc.—The salmon fishery is prosecuted with purse seines, pound nets, or trap nets, and a few gill nets. The Indians employ trolling hooks and spears in the Sound and small streams tributary thereto, and parties fishing for pleasure also use spoon hooks and trolling lines. In autumn, when salmon are most numerous in the sound, Seattle Bay is literally covered with pleasure boats for days in succession.

In the deep, swift waters of Puget and Washington Sounds the purse seine has been found the most effective form of apparatus yet used in the salmon fishery. It was first employed here in 1886, and its introduction is credited to the Chinese. It closely resembles the purse seine employed in the Atlantic fisheries, except that it is fitted with an apron that can be hauled under the bunt in pursing, a device which was first invented for the mackerel seine, though it has not, to my knowledge, been successfully applied in the mackerel fishery. All of the salmon seines, however, do not have this apron. Captain Tanner describes this apparatus as follows:

These seines are 200 fathoms long, 25 fathoms deep in the bunt, and 20 fathoms in the wings; they have a 3-inch mesh. The twine used in their construction is of three sizes, Nos. 12, 15, and 18, No. 12 being used in the bunt, No. 15 at each side of the bunt, and No. 18 in the wings. The foot line is heavily leaded, and the bridles are about 10 feet long. One and one-half inch Russian hemp is used for the purse line. The rings through which the purse line is rove measure about 5 inches in diameter, and are made of small-sized galvanized iron.

The Puget Sound fishermen claimed that this style of purse ring was superior to that used upon the mackerel seines of the eastern coast. They had given the mack-

erel purse rings fair trial and were forced to abandon them, as the purse line would invariably draw twine into the rings, thereby preventing the pursing of the seine. Schools of salmon were often lost from this cause. A subsequent examination of some of the condemned "Gloucester rings," as they were called, showed them to be of the small composition make, such as were employed at one time on the "shoal" or small seines. This kind of ring has not been in use by the mackerel fishermen for 8 or 10 years, having been given up by them for the same reason explained above. There is no apparent reason why the modern mackerel purse ring would not work to advantage on the salmon purse seines of Puget Sound.

The time is not far distant when the combination of Oriental ideas which now prevails in this region will give way to the modern improvements which the American fishermen are bringing with them to the Pacific coast. It will, however, probably take some time to overcome the prejudice which now exists against the introduction of new methods of fishing, as the Greek and Italian fishermen are very conservative and look with disfavor upon any change from the old ways.

A sharpy seine-boat and a scow are required for operating each seine. The former carries 5 men and the latter 4 men, this constituting the regular seine crew. The scow is about 20 feet long and 8 feet wide. It is fitted with an iron winch at each end, for pursing up the seine, and is deemed indispensable for operating a net of this kind. The seine is stowed upon the after part of the seine-boat, about 8 feet of which is decked over at the stern for this purpose. Captain Tanner says:

The method of stowing and throwing the seine differs somewhat from that followed in the mackerel fishery. The salmon seine being thrown over the stern of the boat, it has to be stowed fore and aft instead of athwartship. The corks are placed on the port side, the twine on the starboard side. The twine is thrown in a heap, not arranged neatly in "flakes" and "bits" as upon a mackerel boat, because the man who throws is not particular to have it clear the stern so as not to retard the speed of the boat in going around a school. The result is that the oarsmen have an extra amount of work to perform.

He also gives the following interesting account of the method of fishing with a purse seine in Puget Sound:

Starting upon a fishing trip, the boat, with its scow in tow, is rowed to a favorable locality where salmon are likely to occur, and, having anchored the scow, a lookout is kept for fish. As soon as a school is sighted the boat is shoved off, leaving one end of the seine attached to the scow. A circle is made around the fish, the boat returning again to the scow, when all hands jump aboard of it and commence to haul in on the twine and corks, two men standing at the winches and slowly taking in the slack on the purse line. It is not, however, until half the length of the seine has been pulled in that they begin to purse up in earnest. At this time the anchor rope is slacked off, and, all hands laying hold of the purse line, purse the scow into the middle of the seine. Were this done in the beginning much hard labor could be saved. Time and labor would also be economized by slacking the anchor rope while the first half of the seine is being hauled in, instead of which the seine is hauled bodily through the water.

During the slow process of pursing a man stands at the davit with a long pole, having a block of wood called a "plunger" fastened to it. This is kept working up and down between the purse lines, for the purpose of frightening the fish away from the center of the net; and it is, no doubt, very effective in saving the school, as the bottom of the seine is left open from 25 to 40 minutes, which is ample time for a salmon to find its way out.

From an hour and a half to two hours are required for setting, pursing up, and stowing the seine ready for another trial. On two occasions, when the operations were timed, they consumed on an average 1 hour and 45 minutes.

After the slack of the net is hauled in, so that the fish are "dried up," the salmon are taken out with gaffs and thrown into the well of the scow. Sometimes very large hauls are made with these seines on Puget Sound. For instance, in 1888, on October 28 and 29, two seines belonging to Mr. George T. Myers, of Seattle, fishing off Hat Island, took 28,000 salmon that weighed 210,000 pounds, or an average of 7½ pounds to each fish. At the first haul of one of the seines, at 4.30 a. m., October 28, 6,690 salmon were caught, and it was 11 o'clock a. m. before they were all removed with the gaffs. The other seine, set at the same time, had, by estimate, 10,000 fish; but, owing to the parting of the cork-line, only 3,500 were secured. These hauls were exceptionally large. Some idea can be formed of what is considered an average haul by a perusal of the following figures, kindly furnished by Mr. Myers from his books, each figure representing a single cast:

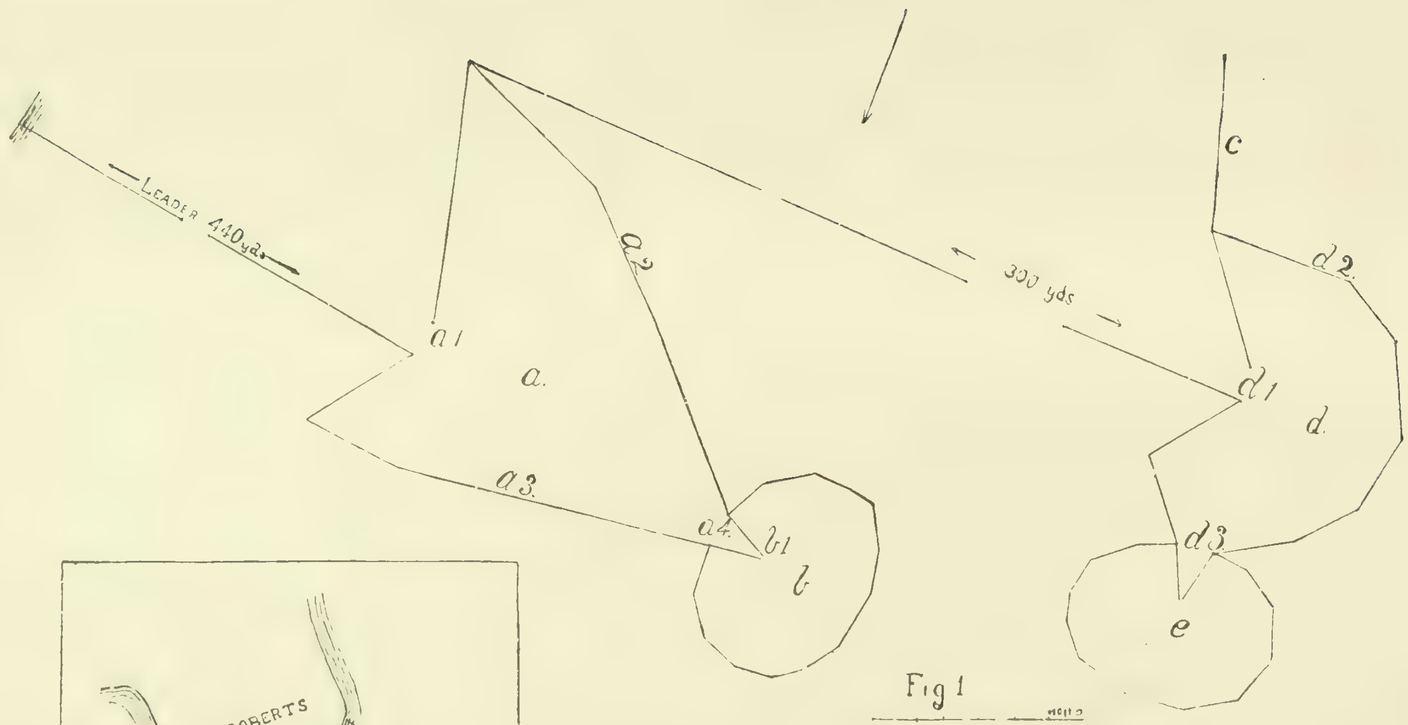
Number of salmon caught at single casts on the dates named.

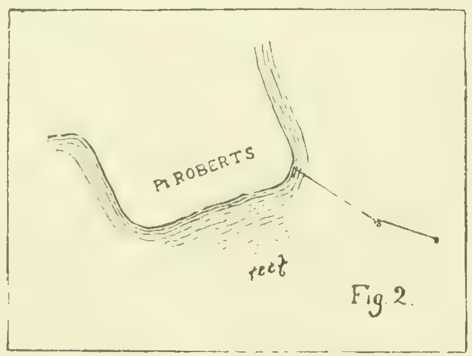
Sept. 23, 1888, 7 seines.	Sept. 26, 1888, 6 seines.	Sept. 30, 1888, 6 seines.
45	83	401
126	998	42
1,495	553	129
1,193	505	1,545
452	124	1,068
403	128	56
163	....	....
3,877	2,391	3,239

Seven pound nets and trap nets were used in the vicinity of Seattle in 1888. They are coming more into popular favor each year, and the number will doubtless be materially increased within a short while. Captain Tanner makes the following reference to these:

There are seven fish traps in Puget Sound, all of which were put down during the spring of 1888. Four are owned by Parker & Felters, proprietors of the Columbia River Cannery at Seattle, who were the first to introduce traps in this locality. Mr. Felters is of the opinion that these appliances will take the place of seines, as there is less expense attendant upon their management. One or two men are sufficient to tend them and keep them in repair. The fishermen about Seattle are strongly opposed to the building of traps, as threatening the future prosperity of the salmon fishery if they are used to any great extent. With the general introduction of traps, requiring much fewer men to carry on the work, the majority of the present fishermen would be forced to seek other employment during the salmon season; and, furthermore, the fishery would soon be broken up, at least to such an extent as to make it unprofitable to more than a very limited number of fishermen.

Up to September, 1888, the traps had taken a large proportion of the salmon brought to the Columbia River Cannery at Seattle. In addition to the traps, this cannery has also two drag and two purse seines fishing for it.





POINT ROBERTS POUND NETS.

FIG. 1. Diagram showing pound nets: *a*, heart of inner pound; *a*1, entrance to heart; *a*2, side of heart, 50 yards long; *a*3, side of heart, 40 yards long; *a*4, entrance to crib; *b*, crib; *b*1, funnel; *c*, wing to outer heart; *d*, heart of outer pound; *d*1, entrance; *d*2, side of heart; *d*3, funnel entrance to crib; *e*, outer crib.

FIG. 2. Location of pound net and reef at Point Roberts.

It is intended to introduce near Seattle a number of fish wheels, like those on the Columbia; they are to be located between some of the islands and worked by the tide.

At Port Townsend gill nets and lines are somewhat sparingly used in the capture of salmon. One vessel (the *Mary Parker*, a sealer) took 380 barrels of salt salmon, worth $2,660, in 1888, using trolling lines. The catch, in addition to the salt fish, consisted of only 10,000 pounds, valued at $450.

At Tacoma 3 seines, 4 pound nets, and about 50 set and drift gill nets were employed in 1888, taking 125,000 pounds of salmon, which were sold fresh for $3,750.

The Indians at Neah Bay use trolling lines, and in 1888 took 7,000 pounds of salmon, valued at $140. A much larger catch could, no doubt, be made at this place, were it not for the fact that the Indians, at the time of the salmon run, are chiefly engaged in hop-picking at places distant from their homes, having already laid in a supply of halibut and other fish to serve for their winter's food.

The aggregate yield of salmon on Puget Sound in 1888 was 1,930,250 pounds of fresh fish and 106,000 pounds of pickled salmon, valued at $41,005 and $3,410, respectively.

The following notes on special devices for fishing, etc., employed in the salmon fishery at Point Roberts have been furnished by Mr. H. B. Kirby:*

In order that the difficulties and drawbacks which I have met with here in setting a trap net which will take salmon in clear water may be understood, the following notes concerning my experience in Puget Sound and the Gulf of Georgia are presented.

It may first be stated that I was a fisherman on the Great Lakes for years before I came West. Soon after reaching Puget Sound I set a pound net in the same manner that they are fished on Lake Superior. This was a complete failure so far as taking salmon is concerned. I did not get over 100 salmon at a lift. Later I met with Lake Erie fishermen who had tried traps for salmon. They said there was too much phosphorescence in the salt water, and because of this salmon would not "lead well" into the pound or bowl.

I fished five seasons for salmon with seines. During that time I devised a plan for a trap that I thought would catch fish in this region. This new pound net was set off Birch Bay Head, in the Gulf of Georgia, on March 15, 1888. It proved a complete success, and caught everything that was running at that time—all kinds of salmon, halibut, cod, flounders, dogfish, herring, smelt, anchovies, sea lions, hair seals, porpoises, sturgeon, ducks, loons, etc. The salmon running at that time were steelheads,

*Point Roberts is close to the boundary line between British Columbia and Washington: it is the northernmost point on the American side from which salmon fishing is prosecuted in this section. These notes were embodied in a letter written to me in March, 1890; they have been somewhat modified for the purpose of adapting them to publication, but the original expressions of the writer have been retained so far as practicable. The notes contain much that is novel, interesting, and instructive, and constitute a valuable addition to our knowlege of the fisheries of this region. With his letter Mr. Kirby sent me some pencil diagrams of the traps at Point Roberts and the canoes fishing on the reef off that place. These have been redrawn, and furnish the illustrations on plates XLIV and XLV.

spring and jack salmon, and a few sockeyes [*O. nerka*]. This trap was set in 22 feet of water, and had a 900-foot leader. The diagrams of the traps set at Point Roberts in 1889 will show the form.

The little trap off Birch Bay Head worked so well that I determined to set a larger one at Point Roberts for the sockeye run, which begins about the 1st of July. This action was taken notwithstanding the late Captain Waller had been experimenting for 12 years with traps at the point for the purpose of taking the sockeye salmon, and had been successful only one season, when fish were so plentiful that there was no market for them. The stories of those who saw his trap fishing do not agree.

It may also be stated that Scotch salmon traps, set with buoys and anchors, Nova Scotia traps, and several other styles, are being tried here every season without success; in fact, they are total failures.

I had fished for sockeyes on the reef off Point Roberts the previous season, and thought my style of trap would work. The first one put down was set in 27 feet of water, and was so placed that it would take the fish before they went over the reef. It worked all right, except the tunnel. The fish would follow the leader and go into the hearts, but would not enter the pot. The water was very clear, and the bottom could be seen at low tide. I thought the tunnel was too small for clear water, though it worked well in March and April, when the wind was blowing most of the time and the water was muddy.

The run of salmon was very small that year; my catch was about 3,000 fish, which was not satisfactory. The next year (1889) I put in 740 yards of leader, with two sets of hearts and two pots [see diagram, plate XLIV]. But fish came so thick that more salmon were caught in one pot than could be taken care of; therefore the outside net was taken up.

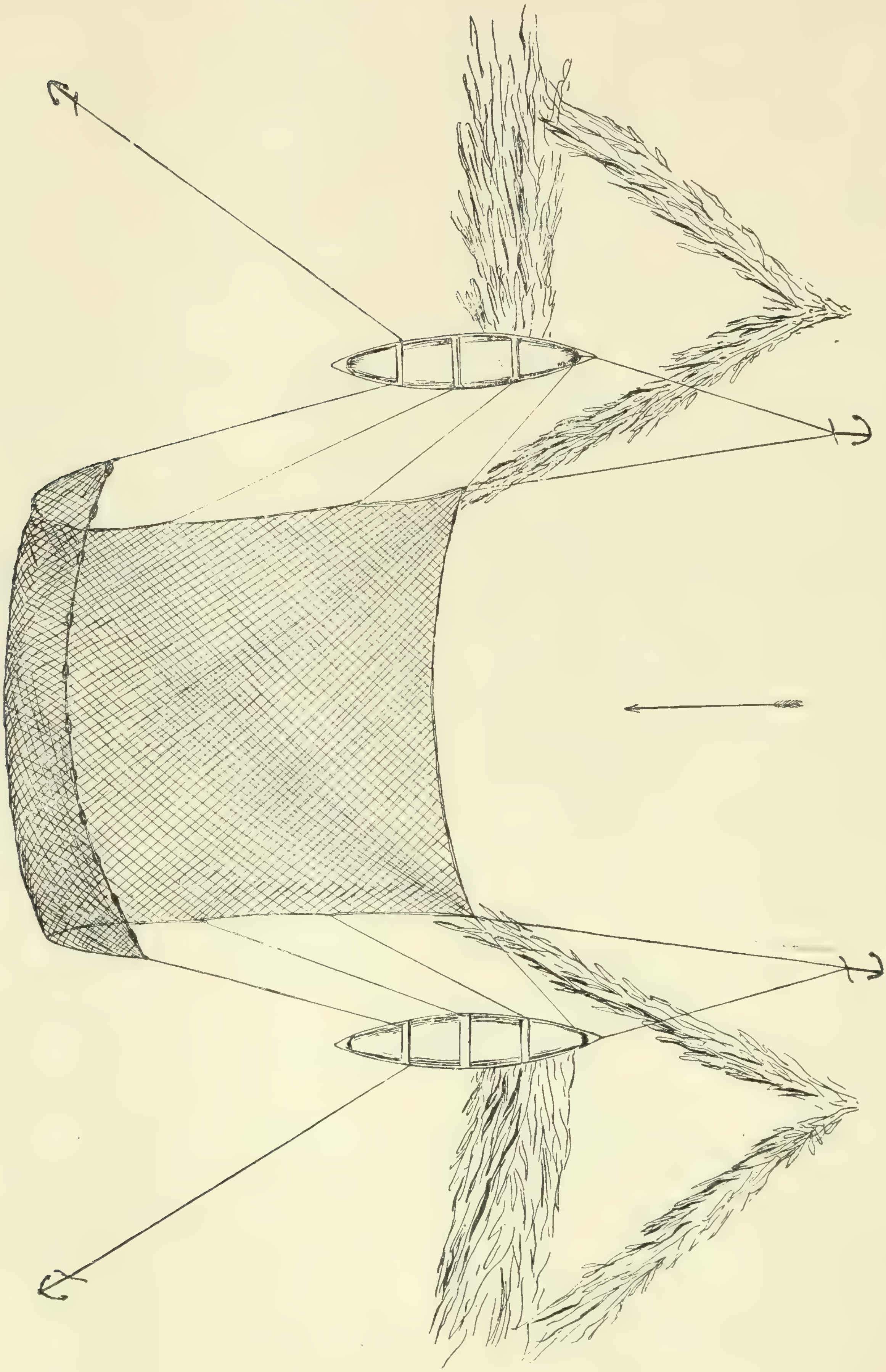
The salmon work into Boundary Bay on high water during the night and go over the reef on the ebb tide. When the run was the heaviest I would open the trap for 2 or 3 hours on the first of the long ebb and would take from 4,000 to 6,000 salmon. That being more fish than could be taken care of the traps were sometimes closed for 2 days. If the fish could have been taken care of it is probable that the catch would have averaged 10,000 salmon per day, which was quite an improvement on the results of the previous year. The only change made in the construction of the nets was that larger tunnels were put in.

The run began July 12 and continued until September 2. It was the heaviest and longest run of sockeyes known for years. With my traps and the reef nets there were about 150,000 sockeye salmon taken at Point Roberts for the season of 1889. The most of these fish went to the Fraser River; about 30,000 went to a small cannery on the American side, and some were salted. The average price paid by the canneries was 9 cents per fish.

A few Indians fish for sockeyes on Stuart Island; their catch was small and was salted.

The fall run of cohoes or silver salmon was very small (in 1889), both on Puget Sound and in the Gulf of Georgia. The catch in the gulf was about 50,000 fish that were canned and 150 barrels salted. I fished one trap 15 days for cohoes and caught about 4,000 salmon. I will remark here that the cohoes run in schools, and do not travel nearly so fast as sockeyes; consequently they can not be so readily taken with a trap net. I have known as many as 8,000 of this species to be taken at one haul with a purse seine. The sockeye salmon does not school after coming into the Gulf of Georgia, therefore it can not be taken in large numbers with a seine. It seems to be continually on the move. When fish of this species are reported opposite Victoria we expect them at Point Roberts in 3 or 4 days, though the places are separated a distance of 65 miles.

The principal drawbacks to trap-net fishing in salt water are the following: First, large quantities of floating seaweed drift into the nets and this has to be removed and carried to the shore in boats; second, hair seals, dogfish, and sturgeon frequently



SALMON-NET FISHING ON "THE REEF" AT POINT ROBERTS.
(Arrow indicates direction of current.)

get into the traps and cause considerable injury to the twine. I have taken as many as 45 sturgeon at one lift, and they would weigh from 100 to 800 pounds each; third, cotton twine lasts a very short time when set in salt water.*

The salmon fishing on the reef, which extends outward from Point Roberts a distance of 2 miles, is mostly done by the Indians. About two-thirds of these fishermen come from British Columbia. In 1889 there were 16 nets operated on the reef. Each net consists of a piece of webbing about 30 by 40 feet, made of 32-thread cotton twine and having a mesh of 3½ inches. It is hung "on a third," with the exception of about 4 feet at one end, where it is taken up sufficiently in hanging to form a small bag at the top of the net.

Each fishing canoe has two places to fish on the reef, one for high water and one for low water; the object being to secure as nearly as possible a depth of water which does not exceed 8 feet.

Under natural conditions the reef is covered with kelp throughout its length, the kelp floating at the top of the water. A channel is cut through this, and in the passageway so prepared the net is set, and short leads of kelp are run out at angles from the opening so as to direct the fish into the net. The kelp is all submerged when the tide is running, but nevertheless has a tendency to lead the fish to the channel.

In operating the net two canoes are so anchored that they will be on opposite sides of the channel, and between them the net is held in position by an arrangement of guy lines. From the head anchor runs a double line, one part extending to the canoe and the other running to the net. What is termed a "side anchor" is placed a little astern, so that by hauling in on the line attached to it the net can be kept taut. As has been stated, there are a number of lines extending from each canoe to the net, and a small stone is bent on to the head anchor line close to the net, so that the latter will sink more quickly than it otherwise would.

The canoes lay side by side in the tide; the net is thrown over, the side lines are set up and spread out, the front of the net goes to the bottom, and the top or back is just under the water. The net is now set for fishing, although three sides of it are open so that fish can go out. Salmon are never meshed in this form of apparatus.

The oldest or best fisherman stands as lookout, and each of the crew has a line leading to the net. When the lookout has seen fish pass on to the net he gives the order to haul in on it, and the sooner the apparatus can be lifted the greater number of fish will be secured. When fish are thus seen the side lines are tripped and the canoes come together so that the net can be gathered up into a sort of bag. The fish are then rolled into the canoes, something after the manner of gathering up a seine, and as soon as the apparatus is emptied it is again thrown over and spread as before. It often happens that salmon are not seen until they have been on the net and have turned to go off. In such cases a water haul is generally the result.

* Mr. Kirby has made an inquiry in this connection as to whether there is any preparation for the preservation of cotton twine which is better than coal tar. I will say that in the preparation of seines and other apparatus for the use of the U. S. Fish Commission I have had them both tarred and tanned. This method of preparation has been found very satisfactory, in that it has all the preservative qualities of coal tar when the net is set in the water, and the additional advantage that the twine is somewhat more flexible and not liable to spoil by heating when dried and packed in bulk. The Dutch method for preserving cotton twine used in the herring gill net is as follows: The tan is made by boiling catechu in water in the proportion of one pound of the former to two and a half gallons of the latter. When it is sufficiently strong the nets are soaked in it for 24 hours, after which they are dried. They are tanned and dried three times, and then soaked in linseed oil. A pound of oil is provided for each pound of net, and they are allowed to remain in it as long as any will be absorbed. They are then well drained and spread out on the ground to dry, after which the process is completed by tanning them once more.

J. W. Collins.

When fish are running in good numbers ten to fifteen Indians form a crew for a reef net, and a haul can be made every minute or two if necessary. Some of the Indians are very expert at this kind of fishing, and have taken as many as 2,000 salmon in a day. In such cases the clutchmen come out with canoes and boat the fish ashore so that the operations of those engaged in fishing will not be interrupted.

The origin of this style of fishing is attributed to one of the Hudson Bay Company's employés, who the Indians say taught them a long time ago how to catch salmon in this manner. At first, they state, their nets were made from the fiber of cedar bark. This style of reef fishing will never be profitable for white men, since it requires too many hands to operate the net, and there are so many days that fishing can not be prosecuted because of muddy water, strong tide rips, etc.

The long ebb and two-thirds of the flood tide run over the reef, and during the set of these tides is the right time for fishing, when the current is not swifter than 5 knots an hour. On high course tides, however, particularly when there is a strong wind blowing outside, the current often reaches a velocity of 8 knots, and reef fishing at such times is impracticable.

Salmon canning.—Although the waters of Puget Sound are capable of maintaining a large salmon fishery, the business of canning salmon has as yet reached only small proportions. Only four factories were located on the Sound in 1888, and all of these were in the vicinity of Seattle or controlled by Seattle parties. One located about 4 miles north of that city was burned in July, 1889; the precise location of the other canneries was, one at Seattle, one at West Seattle, and one at the mouth of the Skywamish River, about 75 miles due north of Seattle.

The 4 canneries were valued at $41,000 and had a cash capital of $68,000; they had 141 employés; 1,538,250 pounds of fish were utilized, with a value to the fishermen of $26,665; 21,975 cases were packed, valued at $126,356; and 150 barrels of salt salmon were prepared.

THE HALIBUT FISHERY.

The halibut fishery from Puget Sound and vicinity can be broadly classified under two heads, the vessel fishery and the shore market fishery. Such matters as relate to the fresh and salt halibut fishery, to the employment of Indians in the shore fishery, to the supplies of halibut obtained and cured by the Indians for their own use, etc., will appear incidentally in the discussion. But, for obvious reasons, most attention will be given here to the vessel fishery, which many hope may develop into a large commercial enterprise.

The vessel fishery.—The vessels, fishermen, boats, apparatus, and methods of capture employed in the vessel fishery were identical with those of New England, and the same system of sharing the proceeds, or "half lay," was observed as at eastern ports. These have been so fully discussed in previous publications of the Fish Commission (see vol. I, sec. V, Fisheries and Fishery Industries of the United States) that it seems unnecessary to refer to them at length here. It will suffice to say that the vessels ranged from 81.28 tons to 117 tons in size. They were some of the best New England clippers. The men had been trained in the

Atlantic fisheries, the boats were the ordinary bank dories, and the halibut were caught on trawl lines.

Narrative of the fishery.—The immediate cause of the attempt to inaugurate the halibut fishery from Puget Sound ports was the publication of a series of letters in the Cape Ann Advertiser, of Gloucester, Mass. The writer of these letters took a very optimistic view of the prospects for establishing a great halibut fishery on the Pacific similar to that prosecuted from Gloucester. The enterprising spirit characteristic of New England fishermen prompted them to consider the matter favorably, particularly as they knew from the most reliable sources that halibut were abundant off Cape Flattery at certain seasons. The pelagic fur-seal fishery was another strong inducement for the eastern fishermen to make the venture of sailing "around the Horn," for some believed that this offered unusual opportunities for financial success, while they thought the period between sealing seasons might be profitably utilized by engaging in halibut fishing. The men who entered upon this experiment were among the most skillful, daring, and adventurous of their class, and, so far as catching fish is concerned, none could be found better fitted for the work.

In the fall and early winter of 1887, three schooners sailed from Massachusetts for Puget Sound. These were the *Mollie Adams* and the *Edward E. Webster*, of Gloucester, and the *Oscar and Hattie*, of Swampscott. The two former were owned by Capt. Sol. Jacobs, who, after dispatching his vessels, crossed the continent in time to make necessary business arrangements pending their arrival. The *Mollie Adams* made a good passage and reached her destination without mishap; but the *Webster* met with an accident to her spars before rounding the Horn; put into Montevideo for repairs; was delayed, and finally arrived on the west coast late in the season. During the passage out her crew suffered from sickness.

The *Oscar and Hattie* reached Puget Sound some time later than the *Adams*, but in time to engage in the halibut fishery, upon which she entered, making her headquarters at Port Townsend. Owing to the want of a suitable market, and to the fact that the schooner had to go to Tacoma to ship her catch east, the fishery from this place was followed with loss rather than profit. The *Oscar and Hattie* carried 6 dories and a crew of 14 men.

About two-thirds of the catch was sold fresh and the remainder was salted. The result of the season's work in 1888 was 240,000 pounds of fresh and salt fish, with a value (at the prices paid the fishermen) of $7,600. The average price received for fresh halibut was 3 cents per pound, and for salt fish 3½ cents a pound.

Captain Tanner makes the following mention of one of her early trips for fresh halibut in 1888:

A fare of 50,000 pounds of fresh halibut was recently taken to Tacoma, Washington, by the schooner *Oscar and Hattie*, this being the first cargo landed and shipped from

that port. The fish were taken in the vicinity of Cape Flattery. Little or nothing was realized from the trip. The ice cost $22.50 per ton, and high rates across the continent were charged by the Northern Pacific Railroad Company, over whose road the shipment was made. After discharging her cargo, the *Oscar and Hattie* proceeded to Port Townsend, where preparations were made for a second trip. An agreement was entered into with a firm at Vancouver to furnish the ice at $10 per ton, but three weeks passed without receiving any, and the schooner was forced to go north in the hope of obtaining a supply from the glaciers in southeastern Alaska.

During the winter of 1888–89 the *Oscar and Hattie* made a trip for salt halibut to Sitka and vicinity, Capt. Silas Calder in command. Captain Calder has had many years' experience in the Atlantic halibut fishery, and was well qualified for this undertaking. Nevertheless, the attempt to secure a fare of halibut in Alaska failed, and the result gives little encouragement to hope for success in winter fishing in that region.* Mr. Alexander had an interview with Captain Calder immediately after the latter's arrival at Port Townsend, and wrote as follows concerning it, under date of June 16, 1889:

Captain Calder informs me that he fished every day that he could. From the 1st of January till the 1st of March they fished in the vicinity of Sitka and found nothing but red rock-cod.

The weather was very blowy. They had no snow or ice to contend with, but high winds prevented their fishing a good deal of the time. From the 1st of March till within a week they fished off the southern end of Queen Charlotte Island, and managed by dint of very hard fishing to pick up 140,000 pounds. The last 3 weeks of their fishing they couldn't get enough to bait up their gear, and, in consequence of the scarcity of fish, only one skate of trawl to a dory was run. Now, last year, Captain Calder found excellent fishing in the same locality. Last season I was informed by him that he thought there would be no difficulty in catching from two to three salt trips a year, but according to his present statement of the halibut fisheries of Alaska the outlook is rather poor. This may be an exceptionally poor year. Another season halibut may be found more plentiful. It will take a series of years to speak knowingly of the Alaskan halibut fisheries.

As soon as the spring months approach the halibut seek the shallow water of the numerous bays and channels. On inquiry as to whether it would pay to follow them into these bays, I was informed that they scatter too much to carry on fishing successfully.

From the foregoing it will be seen that the fare brought in by the *Oscar and Hattie* on this occasion was secured late in the voyage, after the vessel left Alaska.

The *Adams* and the *Webster* made their headquarters at Seattle. The latter did not arrive in time to engage in fishing during the summer of 1888, and the following year both vessels were employed a large part of their time in pelagic fur-sealing. During 1888, however, the *Adams* took 150,000 pounds of fresh halibut, valued at $4,500, and 180,000 of salt halibut worth $6,300.

* On May 24, 1889, Capt. Joshua Brown, of Salem, testified before the Senate Committee on Relations with Canada (then at Tacoma) as follows: "You can not get halibut here in winter. I instructed my captain particularly to ascertain that fact, and he did."

Captain Tanner gives the following account of fresh-halibut fishing by the *Mollie Adams* in the summer of 1888, which shows the abundance of fish at that time:

After disposing of her cargo of seals, the *Mollie Adams* at once refitted for the fresh-halibut fishery, and made four trips in quick succession, landing 145,000 pounds of halibut, the stock of which amounted to $3,000, the crew sharing $75 each. The expenses of the trips were high, however, $15 per ton being paid for ice on the first one, although on a subsequent trip it was obtained at $8 per ton, which was considered very low by the dealers. The high price demanded for ice is one of the chief obstacles to the development of the fresh-halibut business on the Pacific coast. Could this necessary article be obtained at reasonable figures, the western fishermen would stand a better chance of competing successfully with the eastern markets in supplying the fresh trade. The *Mollie Adams* landed her cargo at Seattle. * * *

Capt. S. Jacobs and others interested in the fishery are seriously considering the expediency of building ice houses at Seattle, and making the attempt to cut ice for their own use the coming winter. It is stated that ice 6 inches thick was cut in the vicinity of Seattle during the winter of 1887–88. If this is true, however, it was an exceptional season, as many of the old residents in the region claim that the weather is never cold enough there to make ice over 3 inches thick. Should the effort to obtain the ice in Puget Sound prove unsuccessful, it is thought to be feasible to make use of large scows in bringing down supplies from the glacier region of Alaska. The expense of obtaining the ice by this method, including the cost of building and towing the scows and of cutting the ice, it is considered will be much less than by the present one.

Captain Tanner also makes the following statement concerning a fletched-halibut trip made by the same vessel:

July 24 the schooner *Mollie Adams* left Seattle, bound north on a fletched-halibut trip, the first one of its kind that had been undertaken on the Pacific coast. But few halibut were captured until the schooner arrived off the southern extremity of the Queen Charlotte Islands, where they were found in great abundance and of larger size than on the grounds off Cape Flattery. A few of those taken were estimated to weigh over 300 pounds each. About half of the number obtained were large enough for fletching, the remainder being used as bait or thrown away. The trawls were not left down over night, the fish biting so rapidly that all the available time was occupied in caring for the day's catch. Only one cod was caught during the trip. Dogfish were numerous, but did not seem to interfere with the halibut taking the bait, as is the case at this season farther south.

The fishing was carried on in depths of only 30 to 45 fathoms, so that the use of hurdy-gurdies was not resorted to. Halibut fishing in this region is very much easier than on the Grand Bank. Operations were continued without intermission until August 26, when a severe gale of wind sprang up from the southeast, lasting two days. The heavy sea produced by the storm caused the *Adams* to drag her anchor several times, but she finally "brought up" and rode out the gale without sustaining any damage or loss. This was the first time that this vessel had been tested at her anchor in a heavy sea, and her sea-going qualities were thoroughly established. From the experience of the *Adams* it is probable that fishing vessels would have no difficulty in making two or more fletched trips for halibut each season to the neighborhood of the Queen Charlotte Islands. Such trips made to Greenland and Iceland consume an entire season, and to this extent the fishermen of the western coast have an advantage over those of the eastern coast.

On the morning of September 8 the *Adams*, having "wet" all her salt, started for home with 150,000 pounds of fish. Light winds prevailed during the passage of eight days to Seattle. Previous to the return of the *Adams*, her owner, Captain Jacobs,

had negotiated with the Northern Pacific Railroad Company to transport her cargo across the continent to Gloucester, Mass., at the rate of $1.25 per cwt. Immediately upon her arrival the rate was increased to $1.40 per cwt., which rendered it very doubtful if anything could be realized upon the trip; but the company was finally prevailed upon to return to its earlier figure, and the shipment was accordingly made. The cost of discharging, packing, and shipping the cargo amounted to $1,950. After deducting expenses the members of the crew received $175 each, or at the rate of $9 a day for 19 days' fishing.

Captain Jacobs is considering the expediency of converting the *Mollie Adams* into a steamer. Shorter passages to and from the grounds could be made under steam, especially during the summer when calms and light, variable winds prevail in this region. The amount of time that could be saved in that way would amply repay the cost of altering the vessel.

During 1889 a Seattle firm chartered a San Francisco vessel of 87 tons, and kept her constantly employed in halibut fishing during the summer. Her catch was landed at Seattle and sold locally or shipped to markets within easy reach.

Disposition of products, difficulties, etc.—The successful establishment of a fishing industry depends on the demand for the products, facilities for transportation, and the proper utilization of all available resources for placing the goods upon the market under the most favorable conditions, particularly if there is sharp competition. This applies with special force to the Pacific halibut fishery.

The comparative sparseness of population on the Pacific Slope, the fact that no proper effort had been made to introduce fresh halibut there as a desirable article of fish food, and that no attempt (at least no successful attempt) had been made on the west coast to smoke salt halibut, naturally compelled the fishermen to look to the East for a market. Thus, they had to ship, at great expense, cargoes of fresh halibut to New York, whence the products were distributed to various sections of the country, probably in some cases being sent west nearly half way back to the point from which they originally started. Some of the fish, particularly the earliest shipments, reached their destination in good condition and sold at remunerative prices. Other cargoes arrived on an overstocked market, and had to be disposed of at rates that gave unprofitable returns, while some shipments were not in good condition when they were received at New York, and proved a total loss to the fishermen.

The claim has been made that the financial results of these shipments were often, if not generally, unfavorably affected by a strong combination of Eastern fish-dealers, who, it was believed, manipulated the market so that the Pacific halibut should be placed at a disadvantage. This, added to the excessive freight charges for transportation across the continent, and other incidental expenses, practically placed it beyond the power of the fishermen to compete single-handed against the Atlantic halibut fishery, especially as the conditions for prosecuting the halibut fishery in the Pacific (except the abundance of fish) are less favorable than on the Atlantic. Captain Joshua Brown, owner of the

schooner *Henry Dennis*, made the following allusion to these difficulties in his testimony before the Senate committee, already referred to (see pages 343, 344):

> What would be the use of catching halibut when they could not be brought to market? The transportation charge is so high to New York or Boston that it is impossible to ship these fish. They want about $700 for a car, and $10 a ton for ice, and the fish will shrink 2,000 pounds out of 20,000, and of course we get no drawbacks. We are charged 1¼ cents a pound for the ice that is melted. Then, when we get to New York, we are boycotted and can not sell our fish, from the fact that the Atlantic Halibut Company have formed a trust. * * * Again, we can not come up to Seattle; it would cost us from $100 to $125 to tow to Seattle. There are so many calms, head winds, and heavy currents here in the summer season that sailing vessels can't do it. Perhaps it might do if there was a railroad from Seattle to Port Townsend. You can most always get west winds to Port Townsend and get up there, but the mountains make the winds here at Tacoma variable, and it takes sometimes 3 or 4 days to get up.
>
> * * * * * * *
>
> The weather here is very unfavorable; it is either a calm or a gale of wind, and the wear and tear to vessels on this coast is from 25 to 30 per cent. more than it is on the Atlantic coast. The Pacific Ocean is never tranquil at all, and even in calms the vessel slaps and slaps, and there is such a continual motion that the ironwork wears out, and the sails wear out. * * * On the Atlantic when the wind is done blowing it is still, but on this ocean there is always a swell, and the vessel is always rolling.

The salt halibut has been shipped to Gloucester, Massachusetts, which is the headquarters of the smoked-halibut industry. The first shipment brought good prices and fairly remunerative returns. But the fish did not prove so desirable for smoking as those taken in the Atlantic, and subsequent consignments arrived in more or less bad condition, thus decreasing the demand. This, together with the high transportation charges and the difficulty of shipping salt halibut across the continent in summer (when it is liable to be overheated and spoiled), made it practically impossible to continue this branch of the fishery. At the close of 1889 the outlook for the continuance of the Pacific halibut fishery, as an industry of any considerable importance, was decidedly unfavorable; indeed, there was every prospect that it would be abandoned, or at least reduced to a scale only sufficient to supply the limited local demand.

From the foregoing the following conclusions may be drawn:

To insure the establishment of a successful halibut fishery on a permanent basis, it first seems necessary that there should be railroad communication with Port Townsend, or that steamers should be employed for fishing, and that the transportation agencies should realize the importance of making favorable rates in order to build up the business. The enterprise should also have the advantage of starting with ample capital backed by a knowledge of the business, and with an arrangement whereby the products—at least fresh halibut—can be distributed from some of the large cities of the Central States. The salt halibut should be smoked on Puget Sound. This would obviate

the unnecessary expense incident to shipping fish to Atlantic ports, and would doubtless relieve the fishermen from much sharp competition they have heretofore met with. It is also quite certain that a judicious system of canvassing would lead to the utilization of moderately large quantities of halibut in the towns west of the Rocky Mountains, and a demand thus created would doubtless grow with the increase of population.

But while it is thus believed to be entirely practicable to build up a halibut fishery here of respectable proportions, it will probably be several years before such results are attained, and there are reasons for supposing that it will never rival the halibut fishery of the Atlantic.

Indian shore fishery.—At Neah Bay from 40 to 60 canoes are engaged in halibut fishing from June 15 to August 15. It is thought that perhaps 15 canoes are, on an average, constantly employed. The crews of the canoes number four or five men. About two fares are made each week, or about sixteen trips in a season. The principal fishing grounds are 10 to 15 miles northwest of Cape Flattery, but less important grounds, just out from Neah Bay, are also frequented. Although the catch varies from time to time, the average fare of a canoe is about 100 fish, with an average weight of 25 pounds each. Some halibut, however, weigh as much as 100 pounds. The aggregate annual yield of this fishery is 600,000 pounds, a small amount of which is marketed in Port Townsend and Victoria; but the bulk is dried or smoked and reserved by the Indians for use in the winter. It is said that the Makahs take more care and pains in drying halibut than in the preparation of any other article of food. It is cut into thin ribbon-like strips and carefully dried in the open air, if the weather is favorable; otherwise it is hung up in their "warm" (smoke) houses, and smoked until thoroughly cured. No salt is used on it.*

Their methods and apparatus, both for fishing and curing, are still nearly as primitive as they have been for centuries. They prefer hooks of their own make to those used by white men. Their fishing lines were formerly made of the fiber of cedar roots firmly twisted together, and

* At Neah Bay two large "warm-houses" are utilized for residence purposes and for smoking fish, blubber, etc. These are barn-like structures, one of which is 66 feet long, and the other 92 feet long, 42 feet wide, 14 feet high on the walls, and 32 feet to the ridge pole. A smudge fire of driftwood is kept burning at each end of the building, and around this is a light lattice framework about 10 feet high, upon which are hung strips of fish and blubber for smoking. Along both sides of the building, for its entire length, are raised platforms, about 5 to 6 feet wide, and 1 foot high. These are covered with matting and skin robes of various kinds, upon which the Indians sleep or recline. In the center of the warm-house is an earthen floor that is frequently used for dances. When a dance is in progress the platforms at the sides are filled with men, women, and children, who are spectators, or not at that time participating in the dance. While these two houses are the most important of their kind at Neah Bay, there are many small smokehouses, all of which are called by the Indian name of warm-houses. The latter are separate from the cottages in which the Indians live.

rendered pliable and enduring by being skillfully roasted. Lines made of the giant kelp were also in favor, these being strong and flexible. Wilcox found that they now use cotton lines, as a rule. The hooks are large and clumsy in appearance, having a stout wooden shank, to which is fastened a shorter piece, at an angle of about 15°, by a stout seizing of cedar fiber at the point, and an iron barb is lashed to the shorter piece near its point. Steel hooks are occasionally used by Indians, who consider them inferior to those of their own make.

THE OYSTER FISHERY.

Oysters occur in the headwaters of Puget Sound, and are taken for market only in the vicinity of Olympia and Tacoma, where the beds are exposed at low tide, and it is possible to drive teams directly to the shore and load the bivalves into wagons.

The principal beds, as located on the accompanying chart, to which reference is made, are in Lynch Cove, Dalop Bay, Totten, Eld, Budd's, and Carr's Inlets, and the strait west of Hartstene Island.

At Olympia the oyster business was of considerable importance in past years, but it has greatly declined of late. San Francisco, to which the bulk of the shipments was formerly made, now has large local beds on which it chiefly depends; and the trade with that place has been discontinued. The oyster beds in the vicinity of Olympia are of considerable size. They appear to be depreciating of late, however, owing to the disastrous inroads of starfish and the destructive effects of recent extremely cold weather. The beds are all exposed at low tide, and are worked only at that time. Teams are driven to the beds, and the oysters are gathered by hand, put in sacks, and hauled to the dealers for shipment.

The oysters are very small; the meat is dark in color and has a strong coppery taste. From 700 to 900 are required to fill an ordinary wooden bucket; these produce, when shucked, about one quart of solid meats.

Eighty-seven men, chiefly Indians, were more or less regularly engaged in this industry in 1888. The output amounted to 5,200 sacks of 100 pounds each, and was valued at $14,300, the average price being $2.75 per sack.

The local demand is not sufficient to utilize all the yield, and a considerable trade is carried on with Portland, Seattle, Tacoma, and other adjacent towns. In making shipments the oysters are placed in sacks, each holding six buckets of shell oysters.

The oyster industry of Tacoma is of less extent than that of Olympia. The output in 1888 was 2,700 sacks of 100 pounds each, worth $6,750, or $2.50 per sack.

The combined fishery interests of the various centers on Puget Sound are shown in the tables on the following page, covering the year 1888.

Table of persons employed.

How engaged.	No.
Vessel fisheries	270
Shore fisheries	647
Canneries	141
Total	1, 058

Table of nationality and nativity of persons employed.

Country.	Nationality.				Nativity.			
	Vessel fisheries.	Shore fisheries.	Canneries.	Total.	Vessel fisheries.	Shore fisheries.	Canneries.	Total.
United States	93	194	16	303	74	83	16	173
United States (Indians)	135	299		434	135	299		434
British Provinces	11		2	13	11		2	13
South America		6		6		6		6
Germany						1		1
Italy		45		45		63		63
Portugal	2	14		16	2	24		26
Greece		7		7		7		7
Norway	9	25		34	15	44		59
Sweden	15	42	6	63	28	95	6	129
Russia		15		15		25		25
Japan	5			5	5			5
China			117	117			117	117
Total	270	647	141	1, 058	270	647	141	1, 058

Table of apparatus and capital.

Designation.	No.	Value.
Vessels (tonnage, 688. 68)	14	$54, 600
Outfit		29, 500
Boats	414	28, 660
Apparatus of capture:		
Seines	36	19, 300
Pound nets and trap nets	12	9, 800
Gill nets	87	10, 820
Trawl lines, hand lines, and trolling lines		2, 070
Shore property		43, 000
Cash capital		68, 000
Total		265, 750

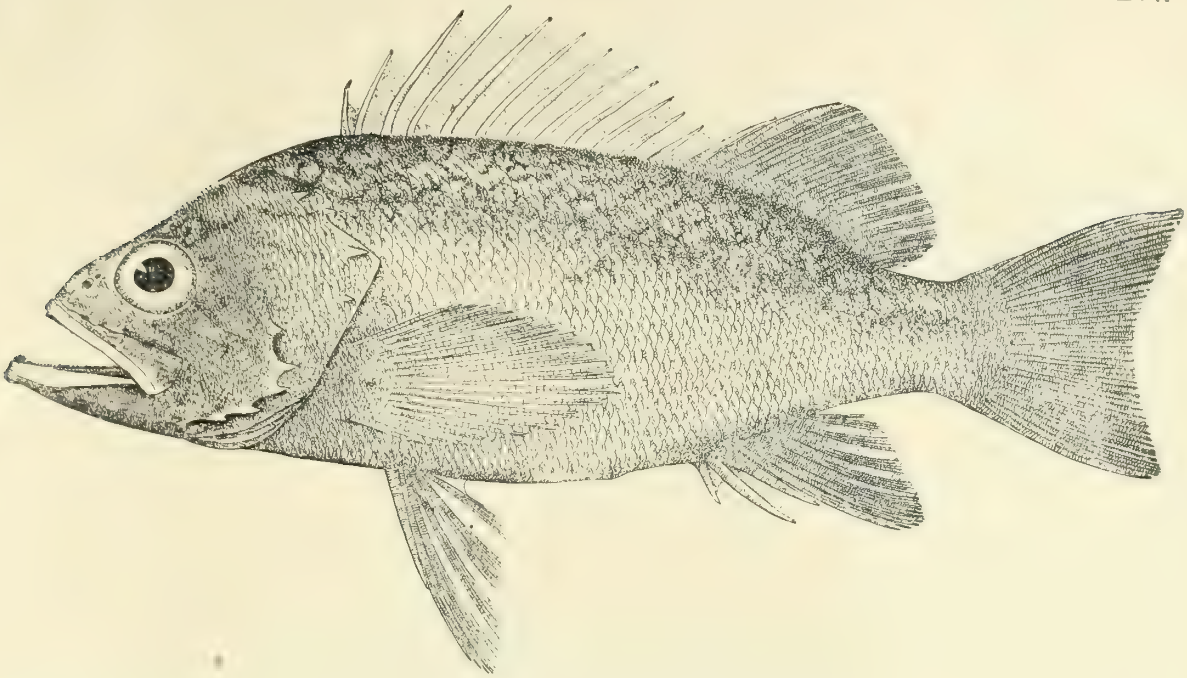
Table of products.

Species.	Quantity.	Value.
Fish.		
Cod, fresh .... pounds	239, 400	$10, 820
Halibut, fresh .... do	*920, 000	21, 800
Halibut, salted ..... do	300, 000	10, 100
Flounders, fresh .... do	175, 000	4, 275
Herring, fresh ...... do	80, 000	2, 000
Perch, fresh .... do	150, 000	3, 875
Rockfish, fresh ..... do	220, 000	6, 825
Salmon, fresh ..... do	1, 930, 250	41, 005
Salmon, salted ...... do	106, 000	3, 410
Smelt, fresh .... do	400, 000	11, 250
Shad, fresh .... do	200	50
Salmon trout, fresh . do	50, 000	4, 000
Sardines, fresh ..... do	60, 000	1, 500
Total	4, 630, 850	120, 910

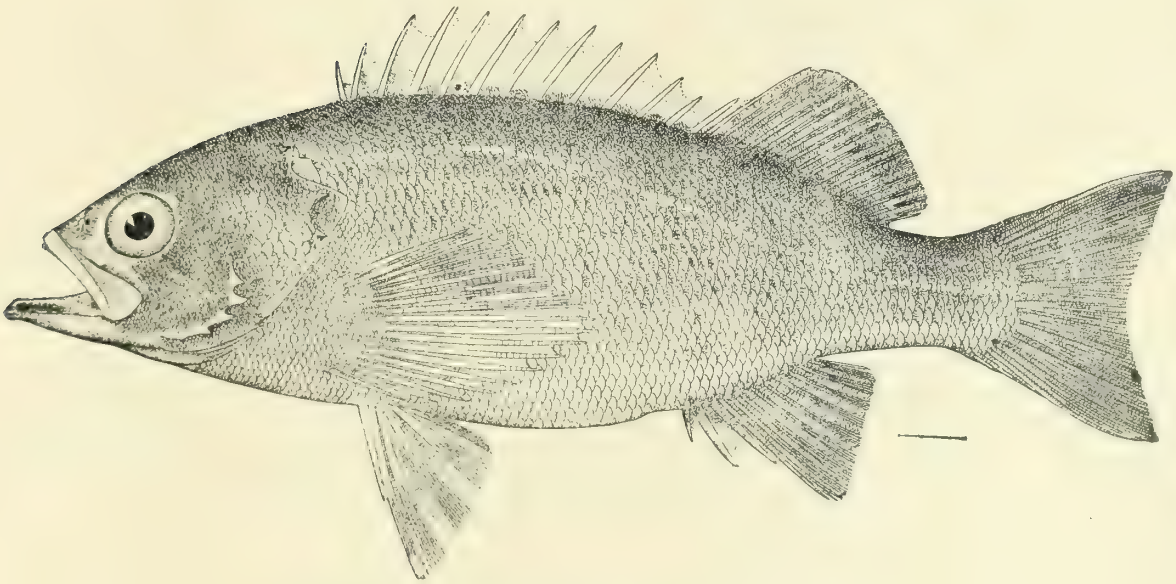
Species.	Quantity.	Value.
Mammals.		
Fur-seal pelts ... number	5, 351	$29, 458
Sea-otter pelts ..... do	30	3, 450
Total	5, 381	32, 908
Mollusks, crustaceans, etc.		
Crabs .... number	7, 500	570
Shrimp .... pounds	5, 000	500
Clams .... pounds, gross	300, 000	3, 200
Oysters .... do	790, 000	21, 050
Dogfish oil .... gallons	10, 000	4, 000
Total		29, 320
Grand total		183, 138

* Including the quantities sold fresh and cured by Indians.

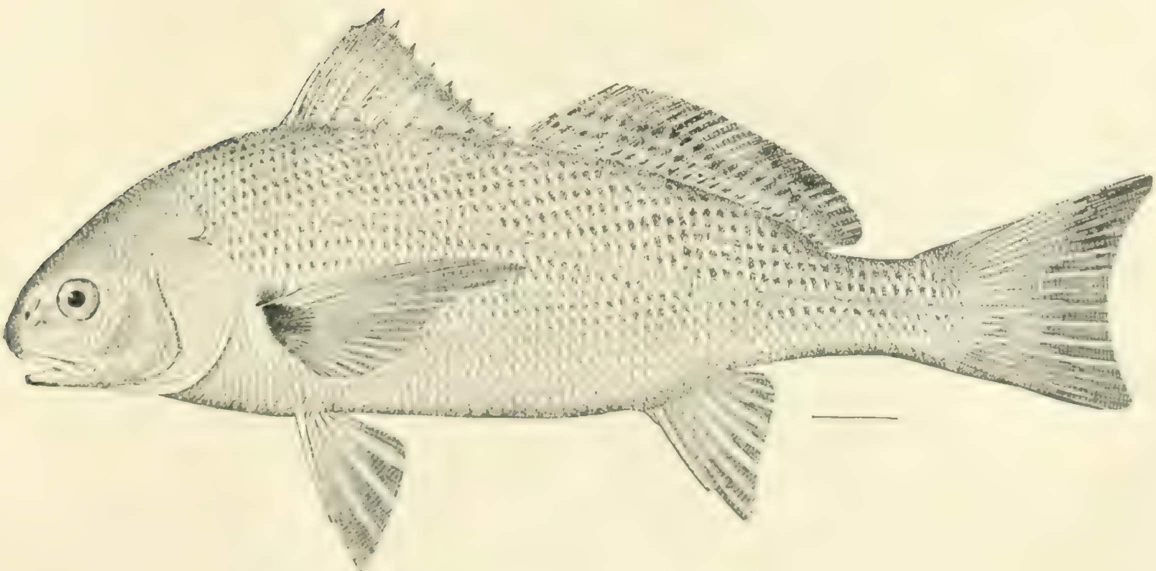
SYNOPSIS.



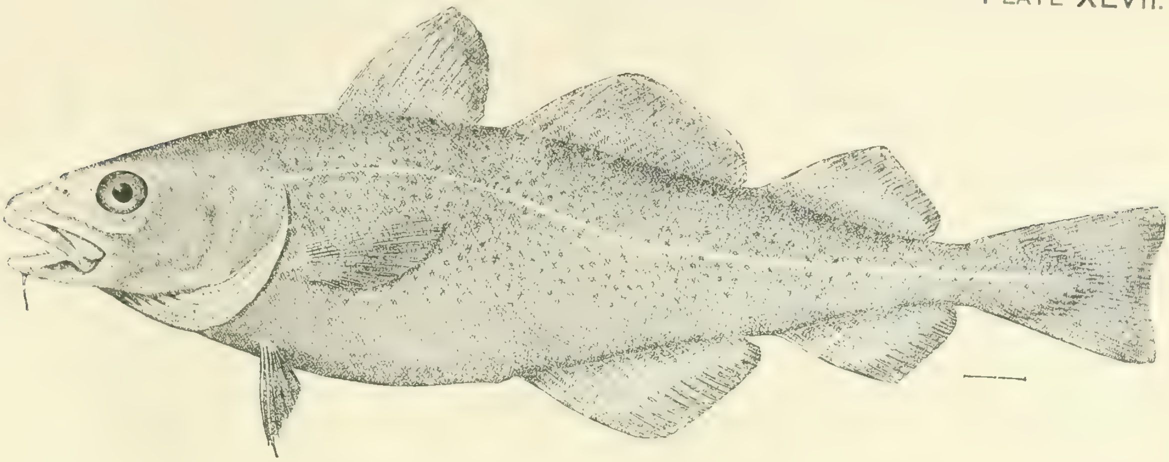
ORANGE ROCKFISH (*Sebastichthys pinniger*).



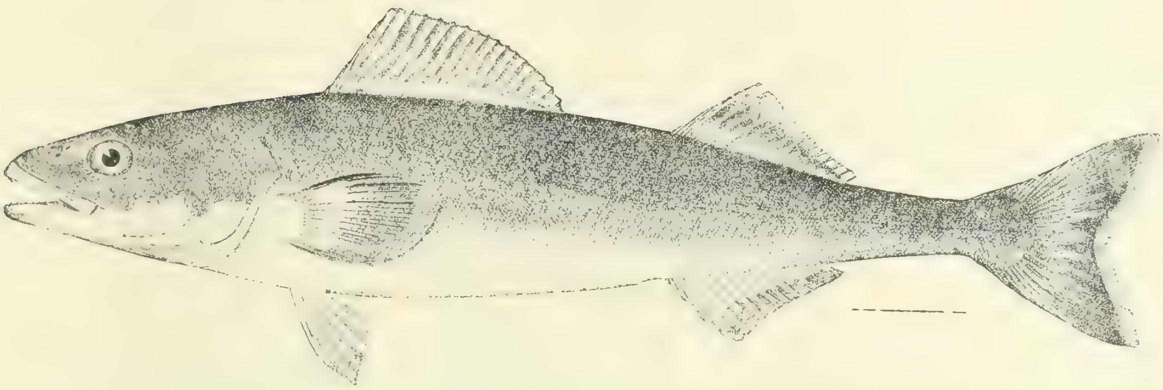
BLACK ROCKFISH (*Sebastichthys mystinus*).



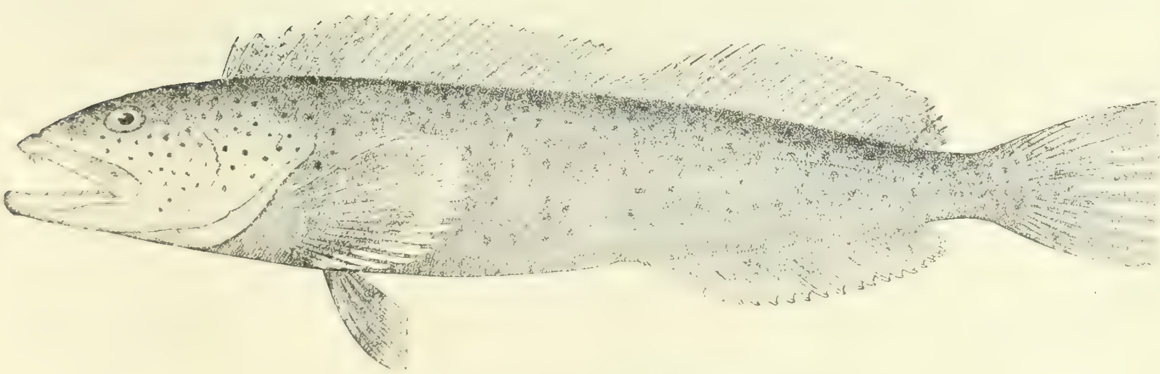
RONCADOR (*Roncador stearnsi*).



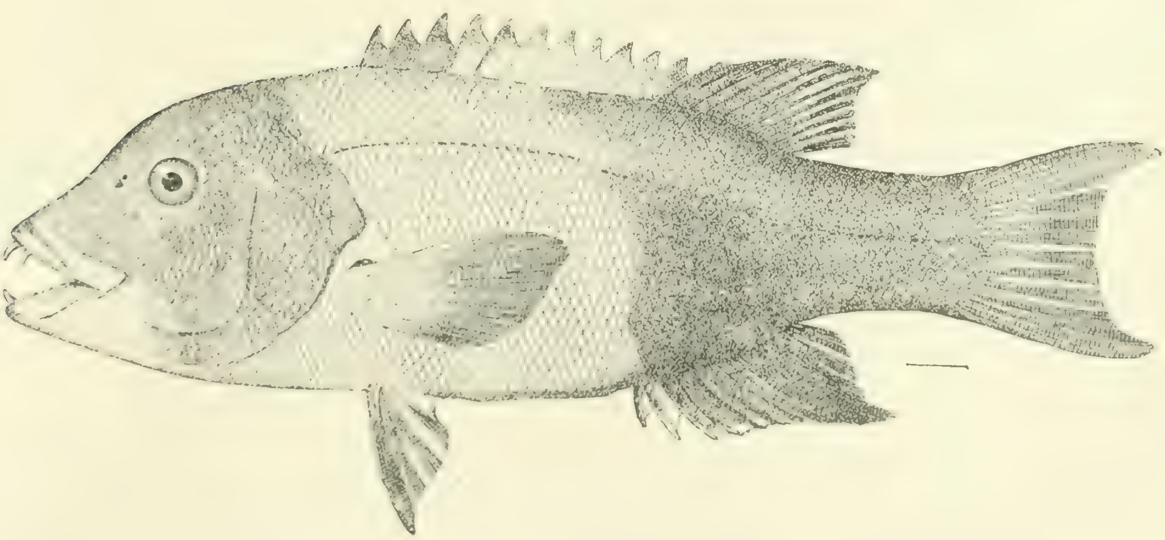
THE COD (*Gadus morrhua*).



BESHOWE OR BLACK COD (*Anoplopoma fimbria*).

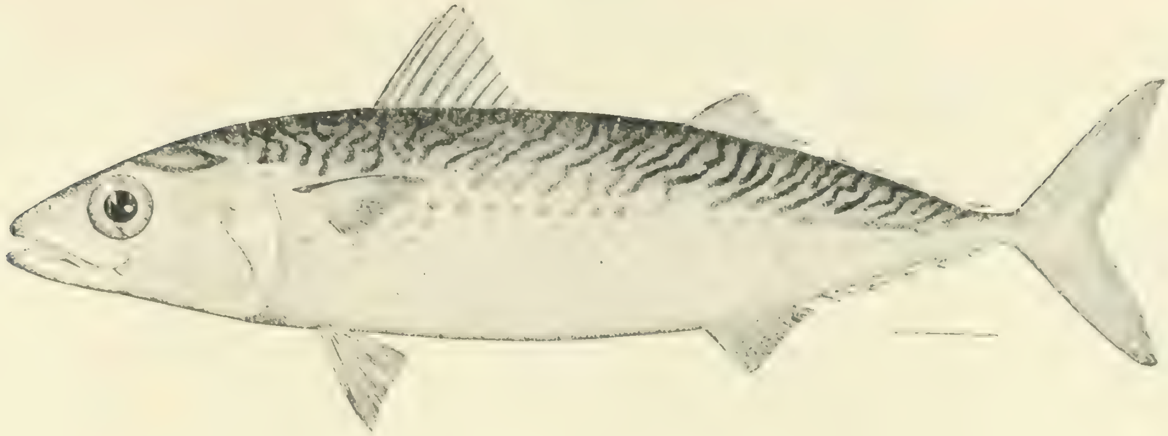


CULTUS COD (*Ophiodon elongatus*).



FAT-HEAD OR REDFISH (*Trochocopus pulcher*).

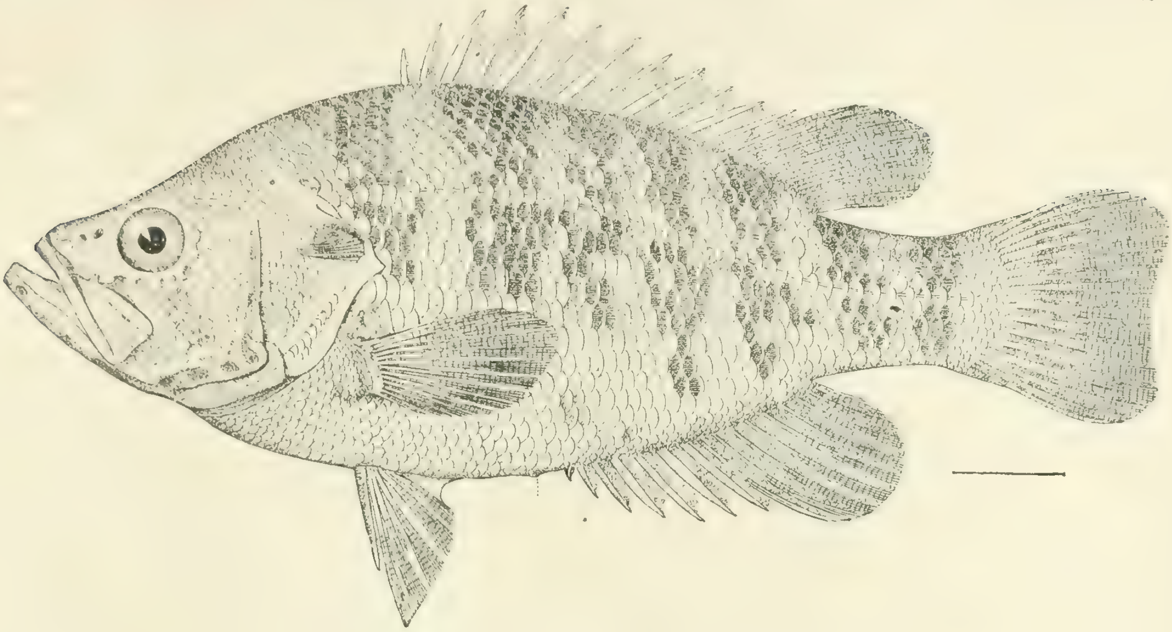
PLATE XLVIII.



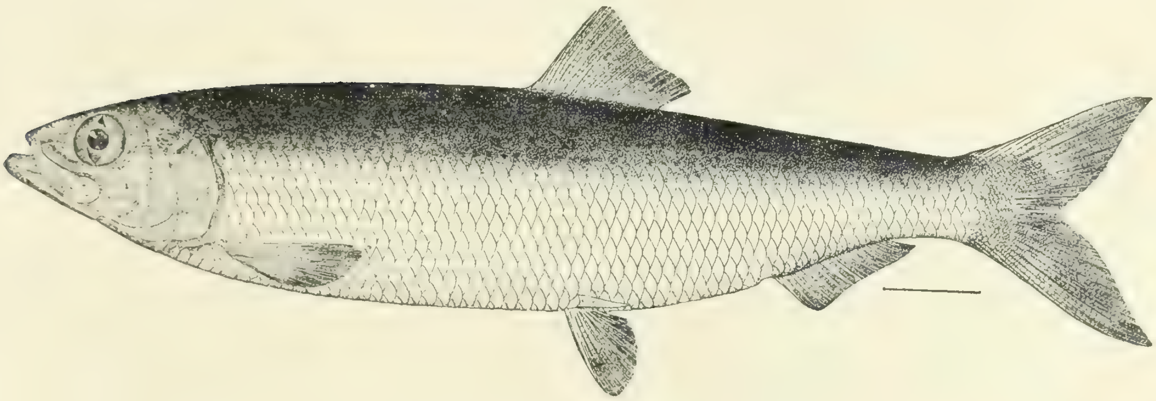
BULL'S-EYE MACKEREL (*Scomber colias*).

YELLOW-TAIL (*Seriola dorsalis*).

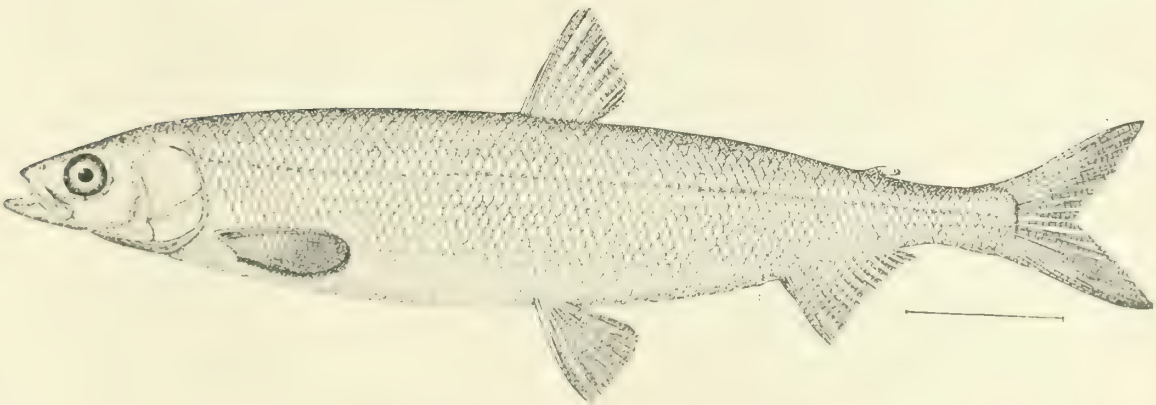
ATKA MACKEREL (*Pleurogrammus monopterygius*).



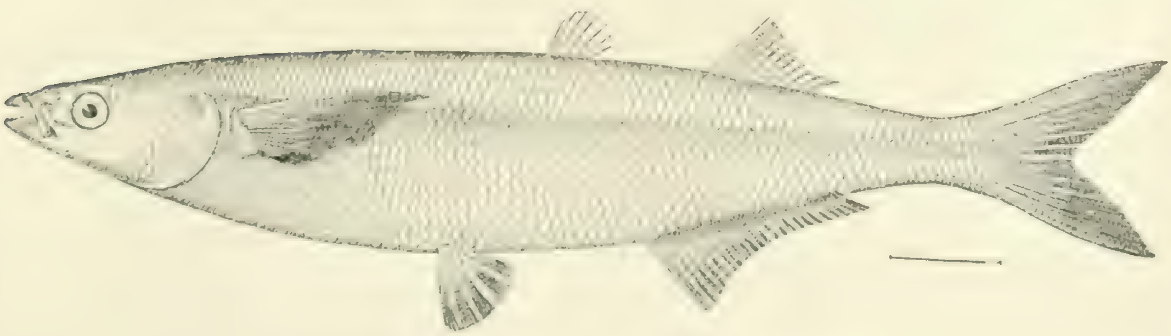
SACRAMENTO PERCH (*Archoplites interruptus*).



CALIFORNIA HERRING (*Clupea mirabilis*).



SURF SMELT (*Hypomesus pretiosus*).



CALIFORNIA SMELT (*Atherinopsis californiensis*).

2.—STATISTICAL REVIEW OF THE COAST FISHERIES OF THE UNITED STATES.

[Prepared under the direction of J. W. COLLINS, Assistant in charge of Division of Fisheries.]

I.—EXPLANATORY NOTES.

Limitation of space.—It seems proper to explain at the outset that the space available for the publication of this review limits the descriptive notes to the smallest proportions, and has also made it necessary to abridge the statistical statements more than was at first contemplated. The material available is sufficient to show in much greater detail the principal features of the fisheries, particularly so far as minor civil divisions are concerned.

Scope and objects of the review.—This report is limited chiefly to the coast fisheries of the United States. As a rule, inquiries have been prosecuted on the coast rivers only to the head of tidewater, though in some cases (especially on the Pacific slope) the canvass was carried sufficiently high to embrace all commercial fishing. In general, the statistics may be said to cover only the coast and sea fisheries, but their scope will appear more clearly in subsequent explanations under each State.

In most cases the period covered by the tables embraces the calendar years of 1887 and 1888. Exceptions to this are the Pacific States and some of the Gulf States, for which figures for 1888 alone are presented.

The review has been compiled with the object of showing the status of the fisheries from various points of view, some of which are novel, so far at least as their application to the whole coast is concerned. The general plan of the arrangement of the tables is as follows:

1. A series of general tables exhibits by States and geographical sections the most prominent features of the fisheries, such as the persons employed in various capacities; the character, quantity, and value of apparatus; the products and values by fisheries. In these tables are also introduced certain comparative statements which are thought to be interesting and valuable as well as novel.

2. A series of tables for each State presents in considerable detail the following points:

a. Persons employed in different capacities.

b. The vessels, boats, and apparatus employed, and the capital invested.

c. The products and values by species.

d. The products and values by vessel and shore fisheries.

e. The products and values by apparatus and species.

In the New England States, where the vessel fisheries are so extensive and diversified, additional tables are given to show the relative importance of the fishing grounds and the fisheries prosecuted thereon by New England vessels. Under the head of each prominent fishing ground the following data are shown:

f. Number and nationality of fishermen.

g. Number, tonnage, and value of vessels.

h. The quantities and values of each species taken.

i. In the mackerel fishery, the relative catch by different forms of apparatus—seines, lines, and gill nets.

In all States having important vessel fisheries, detailed tables are presented showing their extent by customs districts.

No attempt has heretofore been made to show all of these different phases of the fisheries upon a comprehensive scale. Thus, not only is it possible to understand the relative importance of the principal fishing grounds, but these tables exhibit many features of interest in connection with special fisheries for cod, mackerel, etc. A continuation of this system will make it possible to note the changes that occur from year to year in fisheries and fishing grounds, and will furnish valuable assistance in solving the many difficult and intricate international problems arising in connection with the sea fisheries.

Sources of information.—With limited exceptions, the statistics herewith presented are based upon data gathered by the special agents of the U. S. Fish Commission. In some sections, however—notably in the Middle States—the information obtained on Treasury Circular, "Statistics of the Fisheries," has materially aided the Commission in making the compilations complete.

The length of coast line covered by these tables, including the rivers, amounts to an approximate aggregate of 25,215 miles.

General basis for tabulation.—In order to clearly show in one total the entire summation of different branches of the fisheries (by sections or States), it has been found necessary to reduce to the common unit of a pound certain products that are not usually handled on such a basis in the trade. While this is a departure from the ordinary method, it is thought that the end in view justifies it, and it is believed that the explanations that follow will prevent any misunderstanding.

In reading the tables, the principal points to be borne in mind may be briefly summarized as follows:

Oysters: The weight given is for the edible part (meats and liquor); 7 pounds to the bushel.

Round clams or quohaugs (*Venus mercenaria*): Same as oysters; 8 pounds to a bushel.

Long clams (*Mya arenaria*): Same as oysters; 10 pounds to a bushel.

Scallops (*Pecten irradians* and *P. magellanicus*): Weight of "eye" or muscle (the edible portion) is given; 3½ pounds to a bushel.

Oil (whale, seal, and fish): 7½ pounds to a gallon.

The boats carried on vessels are not shown separately, but are included with the outfit.

The values of products are in all cases based on the prices paid the fishermen, or the original cost.

II.—GENERAL STATISTICS.

The series of tables presented under this head exhibits in the most condensed form the information shown in greater detail for each State and for particular fisheries. Special attention is also directed to certain phases of those industries that could not properly be included elsewhere. This arrangement makes it possible to note the salient points at a glance, and besides is convenient for purposes of general comparison.

The tables have been prepared with a view to show by States and by geographical sections the following: (*a*) Persons employed; (*b*) apparatus and capital; (*c*) products and values; (*d*) special features; (*e*) comparative data.

The comparative statements deserve special consideration, and some explanation may be necessary to prevent misapprehensions. In the comparisons which are considered in this discussion an effort has been made to bring the figures of 1880 to cover practically the same area as is included in these tables. It has, however, not always been practicable to do this, and in some cases the figures of the coast fisheries for 1888 have had to stand against totals for States in 1880.

Table 8, which exhibits by States certain averages for vessels employed in fishing in 1888, may be explained as follows:

The large size of the vessels sailing from California and their high relative value is due to the fact that they are mostly whalers, and many of them costly auxiliary steamers. The majority of the vessels in the cod fishery are large as compared with Atlantic fishing craft, and carry more men in their crews. In Massachusetts the vessels average much smaller in size and less in relative value. The explanation for this is found in the fact that many small vessels are employed in the so-called "shore fishery," a branch of fishery as yet not engaged in to any considerable extent by California vessels. The ocean fisheries of New England also employ chiefly sailing vessels less than 100 tons, and this, together with the fact that property of this kind is not held at such high

figures as on the Pacific coast, accounts for the difference that appears in the relative values per ton. It will be seen that the vessels of Washington carry large crews in proportion to their tonnage. Most of these engage in the pelagic seal fishery, and their crews (chiefly Indians) go out from the vessels to hunt in boats.

Table 9, showing the relative rank of the coast States in 1888, based on the value of products in the more important branches of the fisheries, is very suggestive, and brings out certain facts that otherwise might be unsuspected. The most striking of these, perhaps, are the following:

Maryland, which for so many years held unquestioned supremacy in the shellfish fisheries, including the oyster, now takes second place, being surpassed by New Jersey. The material advance which has taken place in the shellfish fisheries of the latter State in recent years has been due to the activity manifested in the artificial planting of oysters and to the large output of clams.

Another notable change is found in the whale fishery. Massachusetts, which has led in this industry since its establishment in America, now drops to second place, and California takes precedence. This is due to the fact that, since the Pacific railroads were built, it has been found most convenient and profitable for the Arctic and Pacific whaling fleets to rendezvous in San Francisco, and vessels belonging to the Atlantic ports have generally shipped their products home by rail instead of sending them by the long and tedious passage "around the Horn." This naturally led to the transfer of vessels and business from New Bedford and other Massachusetts ports to San Francisco, until, in 1888, the result shown in the table has been reached. It may be explained that the trade in California resulting from the landing of cargoes by Massachusetts vessels in San Francisco has not been considered in preparing this statement; the table shows only the relative standing of the two States as based upon the actual value of whale products taken by its vessels or in its shore fisheries.

California also takes a prominent position in the crustacean fishery, while Massachusetts, succeeded by Maryland in rank, has dropped from the second to the fourth place; the loss of position is due entirely to the decline in the lobster fishery.

Among the most striking exhibits of this table may be included the advanced positions taken by the States of Louisiana, Mississippi, and Texas in recent years, particularly in the oyster fishery; Louisiana also holds high rank in the crustacean fishery, ranking fifth on the list, and standing first among the reptile-producing States.

The advance which has been made by Connecticut in the oyster fishery since 1880 deserves to be classed among the most remarkable events connected with our coast fisheries. This State now ranks next to Virginia in the value of the shellfish fisheries, and stands fifth in position. (See Notes on the Oyster Fishery of Connecticut, by J. W. Collins, vol. IX, Bulletin U. S. Fish Commission.)

In connection with the general comparison with 1880 it is worthy of remark that only one of the New England States, New Hampshire, has lost its relative rank; Massachusetts maintains its preëminence; Maine and Rhode Island retain their places as the seventh and eleventh States respectively, while Connecticut advances one position.

Of the Middle Atlantic States, New Jersey takes the lead, assuming third place, which was held by New York in 1880, while the latter State now occupies the fifth place, which New Jersey formerly held. The most noticeable change in this section is that of Delaware, which, on account of the decline in the natural oyster beds of Delaware Bay and consequent loss to the State, has declined from the eighth to the eighteenth place. Pennsylvania has advanced one place, Maryland has dropped from second to fourth place, and Virginia remains in the sixth position.

In the South Atlantic region, North Carolina has dropped back three places, from tenth to thirteenth; South Carolina two places, from seventeenth to nineteenth; and Georgia one place, from twentieth to twenty-first. Only one State, Florida, maintains its former rank.

On the Gulf of Mexico, excluding Florida, there has been considerable shifting of positions. Alabama has been reduced one point, but all the other States have advanced from one to five places.

The Pacific States have materially benefited their relative standing, California changing from fourth to second place, and Oregon and Washington advancing together from the thirteenth and fourteenth positions to the ninth and tenth.

Table 10, showing the percentage of increase or decrease since 1880 will be found instructive. In discussing it we deem it advisable to consider the great geographical sections rather than to speak of the several States in detail, since the same information can be conveyed in this manner without unnecessary elaboration. It will be noticed that there has been a general increase in the personnel and capital employed, amounting to 18 per cent. in the former and 27 per cent. in the latter. Nevertheless, there has been an apparent decline of 1 per cent. in the value of the catch, although there has been an increase in the quantity of products.

The decrease of 11 per cent. in the value of the catch in the New England States may be attributed entirely to the recent exceptional scarcity of mackerel and to the decline in the whale fishery. The decline in the New England whale fishery alone since 1880 amounts to more than the general decrease of 1 per cent. in the coast fisheries of the United States. With these exceptions there has been a general and gratifying increase in the fisheries of this section.

The decline of 9 per cent. in the fisheries of the Middle Atlantic States is attributable to the marked decadence in the oyster fishery, this being the result of more or less unrestricted fishing, particularly in the Delaware and Chesapeake Bays. The general fisheries of this region have improved materially.

The 5 per cent. decrease in the value of the yield of the South Atlantic States is ascribable to practically the same cause as has been mentioned for the Middle States, viz: a marked falling off in the shellfish fishery. Eastern Florida shows an increase in the output of oysters and general products of the fisheries, but there has been a decrease in the three States north of it. In all of these States there has been a slight decline in the value of products of the general fisheries, but the decrease in oysters is most noticeable.

The marked increase of 48 per cent. in the catch of the Gulf States and a still greater advance in the persons and capital employed are due to the development of large areas of new fishing grounds, especially in the oyster industry. The abundance of oysters in certain sections in this region, together with the decrease that has occurred on the coast of the Middle States, has induced capital and labor to seek profitable employment along the Gulf.

On the Pacific Coast the increase in the value of the catch takes precedence of any other section, it being 50 per cent. The advance in the persons employed and capital invested, while large, is less than on the Gulf Coast. The increase is most noticeable in the whale fishery, the shellfish industry, the crustacean products, and the market fishery.

Tables 11 and 12 are comparative statements by States and sections of the quantities and values of shad taken in 1880 and 1888. This comparison has a special interest, since it may fairly be taken as a basis for estimating the effect of artificial propagation of certain species of food-fish which, under natural conditions, have become noticeably depleted. It is proper to state that the supply of shad had been so much reduced by overfishing that in the years immediately succeeding 1880 there was reason to fear that the species would soon become so scarce that it would no longer be available as a reasonably cheap article of food or the object of a profitable fishery.

In order to comprehend the full significance of this comparison, it is well to remember that the artificial propagation of shad on a large scale by the U. S. Fish Commission was not undertaken until 1881; therefore the effect of it upon the abundance of the species could not be felt or observed until 1885, when the artificially hatched fish attained maturity and returned to the rivers for reproductive purposes. It will thus be seen that the excess of the catch of 1888 over that of 1880 practically shows the result attained by artificial propagation of shad in the third season after its effects could, by natural limitations, be observed; and the very important facts are shown that the yield of the fishery was almost doubled, and that its value, based on the prices obtained in 1880, was increased nearly $700,000.

It may be admitted that the increased catch has to some degree been due to the use of larger quantities of apparatus, but it is evident that without a marked increase in the abundance of shad, as a result of arti-

ficial hatching, the profitable employment of additional fishing gear would not be possible. But the fact should not be lost sight of that each year a larger proportion of shad is caught in the bays, estuaries, and lower reaches of the rivers, where pound nets and other gear have been multiplied to such an extent in recent years as to largely prevent anadromous species from ascending to their natural spawning grounds in the headwaters of the streams. For this reason the maintenance of the abundance of shad is more dependent now than ever before upon artificial propagation.

A comparison of the catch of the shad with that of the alewife for the years named will prove instructive, inasmuch as the latter is not hatched artificially, and these species are practically taken in the same waters on the Atlantic Coast and to a large extent at the same season and in the same forms of apparatus. It is only just to say, however, that it is claimed by good authority that the alewife has an advantage over the shad; when it is caught it is commonly in a ripe condition, the adhesive eggs are pressed out in great quantities when the fish are taken in pound nets, and masses of them can generally be seen attached to the apparatus. Nevertheless, the comparative figures in tables 13 and 14 show the alewife catch to have increased only about 23 per cent., while the value of the fish to the fishermen has declined about 5 per cent. This relatively slight augmentation of the catch in 1888, as compared with 1880, indicates an actual diminution in the supply, when the increased quantities of apparatus used for the capture of this species are taken into consideration.

Tables 15 and 16 present an interesting comparative statement of the yield and value of the oyster fishery in the years 1880 and 1888. The preservation of our oyster fishery has become an important economic question, and much attention is now given to it in nearly all coast sections where it is feasible to produce oysters abundantly. In some States laws have been enacted giving certain proprietary rights in areas of sea or river bottom for the cultivation of oysters, and the results have been such as to demand the serious attention of legislators in other States where no such regulations are in force and where there has recently been an alarming depletion of this highly prized article of food.

Taking the country as a whole, there has been only a slight falling off in the oyster product, but this is due to a somewhat remarkable increase in certain sections, which nearly counterbalances the decrease elsewhere. The depletion of the grounds in the most important oyster regions has led capitalists to seek other fields for exploitation, and in this way the oyster industry in the Gulf States has been improved and in some cases created. In other States, as in New England and New York, the increased output is due to wise legislation. It is not practicable to enter into an elaborate discussion of the subject. It will perhaps suffice to call attention to the figures for the Chesapeake Bay region (Maryland

and Virginia) and to Delaware, where the depletion has been most noticeable, and to those for Connecticut, New York, and the Gulf States, where the increase is specially marked. It is also worthy of notice that Pennsylvania on the Atlantic, and California and Oregon on the Pacific, which had no oyster fishery in 1880, according to the census, now make quite a showing, particularly the two former States. The oyster fishery of Washington has also increased in value from $10,000 to $86,574. But, while three of the States have entered upon the oyster fishery since the census year, the State of New Hampshire has abandoned it, though this makes slight difference.

1. *Table showing by States the number of persons employed in the coast fisheries of the United States in* 1888.

States.	Vessel fishermen.	Shore fishermen.	Shoresmen and factory hands.	Total.
Alabama	63	195	60	318
California	1,543	3,188	607	5,338
Connecticut	1,040	1,256	741	3,037
Delaware	145	1,818	131	2,094
Florida	1,055	2,576	286	3,917
Georgia	32	492	114	638
Louisiana	319	3,068	371	3,758
Maine	2,981	6,289	5,901	15,171
Maryland	9,449	14,246	8,256	31,951
Massachusetts	11,091	2,681	3,265	17,037
Mississippi	143	437	800	1,380
New Hampshire	132	197	33	362
New Jersey	1,940	8,112	424	10,476
New York	2,256	3,608	1,193	7,057
North Carolina	288	6,315	1,101	7,704
Oregon	53	3,045	1,584	4,682
Pennsylvania	529	1,174	308	2,011
Rhode Island	417	875	411	1,703
South Carolina	74	1,247	25	1,346
Texas	69	833	119	1,021
Virginia	3,909	6,545	2,161	12,615
Washington	283	2,571	976	3,830
Total	37,811	70,768	28,867	137,446

2. *Table showing by sections the number of persons employed in the coast fisheries of the United States in* 1888.

Section.	Vessel fishermen.	Shore fishermen.	Shoresmen and factory hands.	Total.
New England States	15,661	11,298	10,351	37,310
Middle Atlantic States	18,228	35,503	12,473	66,204
South Atlantic States	404	8,799	1,336	10,539
Gulf States	1,639	6,364	1,540	9,543
Pacific States	1,879	8,804	3,167	13,850
Total	37,811	70,768	28,867	137,446

3. *Table showing by States the number and value of vessels and boats, the quantity and value of apparatus, and the amount of shore property and cash capital employed in the coast fisheries of the United States in* 1888.

States.	Vessels.				Boats.	
	No.	Net tonnage.	Value.	Value of outfit.	No.	Value.
Alabama	26	265.44	$22,400	$5,350	131	$6,810
California	94	12,108.81	1,046,500	447,475	1,354	245,010
Connecticut	221	5,254.56	543,955	140,534	1,354	101,770
Delaware	43	667.13	44,550	2,277	1,019	38,800
Florida	144	2,486.37	230,675	123,474	1,641	136,148
Georgia	12	129.41	8,875	2,940	368	5,246
Louisiana	116	832.46	55,895	22,074	2,347	146,444
Maine	410	14,106.64	689,415	200,454	5,907	235,037
Maryland	1,618	33,456.44	1,436,365	340,725	7,778	392,239
Massachusetts	825	60,129.74	3,047,823	1,541,636	3,333	251,070
Mississippi	42	374.42	24,600	9,305	256	14,526
New Hampshire	14	498.42	27,150	9,901	75	4,220
New Jersey	578	8,708.14	589,385	51,017	5,257	354,325
New York	738	10,053.93	1,000,215	293,755	3,590	210,805
North Carolina	104	1,061.02	63,520	9,375	3,151	170,189
Oregon	13	422.30	74,050	11,400	1,545	201,095
Pennsylvania	81	1,983.54	167,350	23,920	374	15,120
Rhode Island	73	1,481.51	197,375	29,595	749	91,679
South Carolina	17	257.85	22,350	5,300	526	19,454
Texas	19	188.08	12,085	3,090	752	92,739
Virginia	894	14,907.14	740,020	153,979	4,486	203,793
Washington	17	752.73	71,600	31,520	1,202	145,880
Total	6,099	170,126.08	10,116,153	3,459,096	47,195	3,082,395

States.	Apparatus of capture.					Shore and other property.	Cash capital.	Total.
	No. of seines.	No. of gill nets.	No. of pound nets, etc.	No. of pots, fykes, and other small traps.	Value of foregoing and all other apparatus.			
Alabama	6				$5,160	$14,184	$8,000	$61,904
California	1,629	2,367		1,490	354,675	323,050	267,500	2,684,210
Connecticut	56	61	118	12,140	107,920	1,622,135	353,000	2,869,314
Delaware	229	1,454	11	1,887	65,897	49,980	30,500	232,004
Florida	138	1,042	3		59,964	143,145	30,000	723,406
Georgia	26	159	6	14	11,395	27,100	10,000	65,556
Louisiana	153			4,280	42,267	234,047	164,200	664,927
Maine	173	4,328	662	112,902	415,699	766,716	716,600	3,023,921
Maryland	479	7,460	599	11,402	336,488	1,753,659	2,029,493	6,288,969
Massachusetts	378	4,750	218	29,363	968,298	3,050,738	4,251,200	13,110,765
Mississippi	44	14		8	7,457	93,194	180,550	329,632
New Hampshire	8	152	13	2,290	22,873	38,000	5,000	107,144
New Jersey	424	2,963	136	6,114	290,054	201,054	59,000	1,544,835
New York	267	812	199	21,655	206,384	1,620,150	1,196,180	4,527,489
North Carolina	732	61,630	797	133	287,344	192,946	78,100	801,474
Oregon	25	2,545	56		437,943	619,294	952,850	2,296,632
Pennsylvania	94	190		2,077	43,326	380,450	597,000	1,227,166
Rhode Island	59	105	166	6,049	115,742	353,485	235,000	1,022,876
South Carolina	32	229		32	15,585	22,500	12,000	97,189
Texas	125			481	21,237	62,210	23,150	214,511
Virginia	191	1,890	991	219	339,930	464,203	306,300	2,208,225
Washington	59	1,130	159		402,177	333,220	533,000	1,517,397
Total	5,327	93,281	4,134	212,536	4,557,815	12,365,460	12,038,623	45,619,546

4. *Table showing by sections the number and value of vessels and boats, the quantity and value of apparatus, and the amount of shore property and cash capital employed in the coast fisheries of the United States in* 1888.

Section.	Vessels.				Boats.	
	No.	Net tonnage.	Value.	Value of outfit.	No.	Value.
New England States	1,543	81,470.87	$4,505,718	$1,922,120	11,418	$683,776
Middle Atlantic States	3,952	69,776.32	3,977,885	865,673	22,504	1,215,082
South Atlantic States	136	1,501.99	97,945	18,715	4,527	220,224
Gulf States	344	4,093.06	342,455	162,193	4,675	371,332
Pacific States	124	13,283.84	1,192,150	490,395	4,101	591,985
Total	6,099	170,126.08	10,116,153	3,459,096	47,195	3,082,399

Section.	Apparatus of capture.					Shore and other property.	Cash capital.	Total.
	No. of seines.	No. of gill nets.	No. of pound nets, etc.	No. of pots, fykes, and other small traps.	Value of foregoing and all other apparatus.			
New England States	674	9,396	1,177	162,744	$1,630,532	$5,831,074	$5,560,800	$20,134,020
Middle Atlantic States	1,684	14,769	1,936	43,354	1,282,079	4,469,496	4,218,473	16,028,688
South Atlantic States	835	62,439	803	179	343,159	283,746	110,100	1,073,889
Gulf States	421	635	3	4,769	107,250	505,580	395,900	1,884,710
Pacific States	1,713	6,042	215	1,490	1,194,795	1,275,564	1,753,350	6,498,239
Total	5,327	93,281	4,134	212,536	4,557,815	12,365,460	12,038,623	45,619,546

5. *Table showing by States the values of the various coast fisheries of the United States in* 1888.

States.	General fisheries.	Oyster and other shellfish fisheries.	Reptilian fisheries.	Crustacean fisheries.	Menhaden fishery.	Whale and porpoise fisheries.	Seal, walrus, and sea-otter fisheries.	Sponge fishery.	Total.
Alabama	$32,386	$32,174	......	$11,000	......	......	......	......	$75,560
California	1,091,398	679,655	$15,060	186,883	......	$690,729	$1,799,644	......	4,463,369
Connecticut	261,255	1,066,008	1,290	86,023	$89,499	10,784	11,200	......	1,526,059
Delaware	173,456	20,160	2,297	13,640	......	......	......	......	209,553
Florida	468,292	57,552	16,854	5,894	......	......	......	$253,690	802,282
Georgia	39,923	29,370	6,075	7,542	......	......	......	......	82,910
Louisiana	200,215	230,820	60,738	121,047	......	......	......	......	612,820
Maine	1,533,910	239,043	......	516,073	3,017	......	......	......	2,292,043
Maryland	650,455	2,889,060	22,237	198,769	52,678	......	......	......	3,813,199
Massachusetts	5,242,054	257,589	......	173,386	6,250	676,216	......	......	6,355,495
Mississippi	49,230	157,463	......	24,194	......	......	......	825	231,712
New Hampshire	83,638	150	......	6,256	......	......	......	......	90,044
New Jersey	984,376	3,126,067	1,652	78,570	7,885	......	......	......	4,198,550
New York	676,486	2,286,880	1,230	69,137	314,118	......	......	......	3,347,851
North Carolina	680,312	52,459	4,536	5,760	17,247	16,125	......	......	776,439
Oregon	1,010,843	13,575	......	716	......	......	......	......	1,025,134
Pennsylvania	163,306	165,339	......	......	15,359	......	......	......	344,004
Rhode Island	288,932	311,836	......	29,047	195,277	......	......	......	825,092
South Carolina	121,256	19,146	3,485	19,770	......	......	......	......	163,657
Texas	134,994	109,633	14,280	12,350	......	......	......	......	271,257
Virginia	669,622	1,026,918	17,672	24,669	97,274	......	......	......	1,836,155
Washington	767,108	89,774	......	1,070	......	......	32,908	......	890,860
Total	15,323,447	12,860,671	167,406	1,591,796	798,604	1,393,854	1,843,752	254,515	*34,234,045

* The total value of the yield of the coast fisheries, including the rivers that were not canvassed in their entirety but for which approximate figures are given under each State, was $35,222,929, or $988,884 more than represented in this table. The combined sum has been used in making comparisons with 1880.

6. *Table showing by sections the values of the various coast fisheries of the United States in 1888.*

Section.	General fisheries.	Oyster and other shellfish fisheries.	Reptilian fisheries.	Crustacean fisheries.	Menhaden fishery.	Whale and porpoise fisheries.	Seal, walrus, and sea-otter fisheries.	Sponge fishery.	Total.
New England States	$7, 409, 789	$1, 874, 626	$4, 290	$810, 785	$294, 043	$687, 000	$11, 200	....	$11, 088, 733
Middle Atlantic States	3, 317, 701	9, 514, 424	45, 088	384, 785	487, 314	....	....	....	13, 749, 312
South Atlantic States	990, 503	114, 079	19, 972	38, 966	17, 247	16, 125	....	....	1, 196, 892
Gulf States	736, 105	574, 538	85, 996	168, 591	....	....	....	$254, 515	1, 819, 745
Pacific States	2, 869, 349	783, 004	15, 060	188, 669	....	690, 729	1, 832, 552	....	6, 379, 363
Total	15, 323, 447	12, 860, 671	167, 406	1, 591, 796	798, 604	1, 393, 854	1, 843, 752	254, 515	34, 234, 045

7. *Table showing by States the extent of the menhaden industry in* 1887 *and* 1888.

States.	No. of factories in operation.		Number of persons employed.				Value of plants.		Cash capital.	
			Factorymen.		Fishermen.					
	1887	1888.	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
Maine	....	1	.....	40	......	22*	....	$20, 000	....	$5, 000
Rhode Island	3	3	177	246	259	225	$193, 000	193, 000	$69, 000	70, 000
Connecticut	3	3	53	51	141	111	34, 200	34, 200	16, 000	16 200
New York	11	11	428	465	378	451	177, 500	203, 300	129, 000	197, 000
New Jersey	8	7	116	92	139	110	89, 800	73, 800	57, 300	49, 000
Delaware	2	2	88	88	[107	84]†	43, 300	43, 500	40, 000	30, 000
Maryland	3	3	48	55	81	71	17, 800	27, 800	28, 500	30, 500
Virginia	26	19	437	345	778	644	170, 950	161, 150	205, 300	182, 300
North Carolina	8	6	109	94	142	119	34, 700	30, 900	26, 100	24, 100
Total	64	55	1, 456	1, 476	1, 918	1, 753	761, 250	787, 650	571, 200	604, 100

States.	Steamers.							
	No.		Net tonnage.		Value.		Value of apparatus and outfit.	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
Maine	.....	(*)	.....	....	....	......	....	......
Rhode Island	11	11	766. 88	747. 56	$126, 000	$135, 000	$30, 000	$29, 000
Connecticut	7	5	487. 49	365. 11	65, 300	51, 600	10, 800	8, 500
New York	18	22	978. 90	1, 206. 39	176, 000	218, 750	40, 050	48, 730
New Jersey	5	3	186. 70	114. 25	47, 500	27, 000	8, 250	4, 950
Delaware†	5	4	368. 11	305. 57	49, 000	41, 000	8, 400	6 900
Maryland	2	3	136. 26	198. 89	14, 000	20, 000	4, 800	5, 600
Virginia	10	11	423. 14	505. 35	48, 800	64, 000	19, 900	20, 600
North Carolina	1	1	44. 15	44. 15	9, 000	9, 000	2, 000	2, 000
Total	54	55	3, 024. 52	3, 181. 61	486, 600	525, 350	115, 800	119, 380

States.	Sailing vessels.							
	No.		Net tonnage.		Value.		Value of apparatus and outfit.	
	1887.	1888.	1887.	1888.	1887.	1888	1887.	1888.
Maine	.....	(*)	....	90. 59	....	$4, 700	.....	$2, [illegible]
Rhode Island	1	1	27. 50	22. 44	$1, 500	1, 000	$1, 000	700
Connecticut	.....	......	......	......	....	......	......	......
New York	5	5	92. 78	92. 08	6, 400	6, 150	4, 380	4, 300
New Jersey	6	6	116. 79	120. 96	4, 800	5, 800	6, 830	5, 750
Delaware	.....	......	......	......	....	......	......	......
Maryland	3	2	111. [illegible]	58. 10	5, 100	3, 300	3, 500	2, 200
Virginia	54	40	1, 691. 05	1, 26[illegible]	80, 750	52, 850	57, 930	39, 350
North Carolina	12	9	167. [illegible]	134. 79	9, 300	7, 800	10, 075	8, 325
Total	81	66	2, 207. 02	[illegible], 771. 86	107, 850	81, 600	82, 715	63, 025

* The figures for Maine do not include the fishermen and vessels from another State that devoted a portion of their time to fishing in Maine waters but were chiefly engaged elsewhere.

† These figures have been included under Connecticut and do not appear in the footings. Delaware has no fishermen or vessels engaged in the menhaden fishery.

7. *Table showing by States the extent of the menhaden industry in* 1887 *and* 1888—Cont'd

States.	Sailing vessels used as lighters.								Total capital invested in the industry.	
	No.		Net tonnage.		Value.		Value of outfit.			
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
Maine	....	1	....	6.83	.....	$160	....	$50	....	$32,310
Rhode Island	3	5	42.32	64.08	$1,400	1,825	$180	265	$422,080	430,790
Connecticut	3	3	30.51	30.51	1,500	1,435	240	240	128,040	112,175
New York	5	6	62.65	69.55	3,900	4,500	350	425	537,580	683,155
New Jersey	10	9	126.21	105.77	6,650	6,250	710	650	221,840	173,200
Delaware	.....	.....	....	....	....	....	....	......	83,300	73,500
Maryland	4	3	94.35	63.10	4,800	3,500	250	200	78,750	93,100
Virginia	31	20	964.61	717.49	45,050	31,150	2,400	2,000	631,100	553,400
North Carolina	12	9	106.46	78.71	5,900	5,550	600	450	97,675	88,125
Total	68	56	1,426.11	1,236.04	69,200	54,370	4,730	4,280	2,200,365	2,239,755

States.	Menhaden handled.				Oil manufactured.			
	Number.		Value to fishermen.		Gallons.		Value.	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
Maine	....	6,666,000	....	$7,000	....	79,000	......	$16,590
Rhode Island	60,901,670	127,169,670	$73,072	155,004	538,623	762,360	$129,539	168,418
Connecticut	54,000,000	59,620,000	71,133	80,990	94,380	143,600	24,155	37,960
New York	114,633,200	219,970,910	166,409	314,118	814,671	1,248,008	170,979	349,454
New Jersey	27,915,000	27,252,000	31,265	30,512	176,600	86,768	38,899	26,214
Delaware	34,460,000	24,000,000	46,521	32,940	232,300	153,870	61,829	48,572
Maryland	12,210,000	18,974,050	16,789	21,345	71,500	44,850	16,115	12,008
Virginia	128,415,000	103,099,300	175,928	115,471	759,187	249,241	138,414	65,893
North Carolina	24,594,000	22,964,000	18,446	17,247	98,200	50,400	24,550	12,600
Total	457,128,870	609,715,930	599,563	774,627	2,785,461	2,818,097	604,480	737,709

States.	Scrap prepared.								Total value of manufactured products.	
	Crude and acidulated.		Dry.		Total.		Value.			
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*				
Maine	......	540	....	....	....	540	......	$5,400	....	$21,990
Rhode Island	1,360	2,951	2,450	5,600	3,810	8,551	$81,010	166,268	$210,549	334,686
Connecticut	515	1,170	730	670	1,245	1,840	23,310	30,570	47,465	68,530
New York	100	7,455	8,586	13,045	8,686	20,500	198,976	421,835	369,955	771,289
New Jersey	783	1,534	1,460	2,243	2,243	3,777	47,455	41,035	86,354	67,249
Delaware	1,330	1,250	1,670	550	3,000	1,800	57,030	30,700	118,859	79,272
Maryland	615	1,205	510	638	1,125	1,843	18,900	28,134	35,015	40,142
Virginia	1,752	2,778½	7,842	5,159½	9,594	7,938	191,991	155,391	330,405	221,287
North Carolina	60	......	1,638	1,555	1,698	1,555	42,060	38,875	66,610	51,475
Total	6,515	18,883½	24,886	29,460½	31,401	48,344	660,732	918,211	1,265,212	1,655,920

8. *Table showing by States certain average figures for the vessels employed in the coast fisheries of the United States in* 1888.

States.	Number of crew.	Net tonnage.	Value of vessel.	Value of apparatus and outfit.	Stock per vessel.	Stock per man.
Alabama	6.0	30.42	$2,000	$1,011	$2,886	$481
California	20.2	138.32	10,748	5,394	12,812	640
Connecticut	4.8	24.76	2,531	816	3,855	789
Delaware	3.7	12.38	965	172	1,086	291
Florida	7.7	17.82	1,631	934	2,492	324
Georgia	2.7	10.78	740	285	802	301
Louisiana	2.7	7.22	454	193	829	309
Maine	7.8	41.16	1,725	1,075	2,305	297
Maryland	6.4	17.76	774	324	1,318	205
Massachusetts	13.6	73.62	3,735	2,717	6,375	469
Mississippi	3.4	8.91	586	288	1,517	446
New Hampshire	9.4	35.60	1,939	1,868	3,906	414
New Jersey	3.4	14.28	969	172	1,153	337
New York	3.2	13.22	1,414	534	2,954	914
North Carolina	4.3	10.76	783	323	662	154
Oregon						
Pennsylvania	6.9	24.91	2,167	469	3,197	460
Rhode Island	6.3	21.08	3,034	679	4,579	733
South Carolina	4.6	16.03	1,057	331	1,162	253
Texas	3.6	9.90	636	265	1,171	322
Virginia	5.1	14.59	740	317	925	182
Washington	20.5	52.47	4,038	2,208	4,230	206

9. *Table showing by fisheries the relative rank, based on value of products, of the coast States in* 1888, *together with a general comparison with* 1880.

Rank.	General fisheries.	Oyster and other shellfish fisheries.	Reptilian fisheries.	Crustacean fisheries.	Menhaden fishery.	Whale and porpoise fisheries.	Seal, walrus, and sea-otter fisheries.	Sponge fishery.	Total.	
									1888.	1880.
1	Mass	N. J	La	Me	N. Y	Cal	Cal	Fla	Mass	Mass.
2	Me	Md	Md	Md	R. I	Mass	Wash	Miss	Cal	Md.
3	Cal	N. Y	Va	Cal	Va	N. C	Conn		N. J	N. Y.
4	Oregon	Va	Fla	Mass	Conn	Conn			Md	Cal.
5	N. J	Conn	Cal	La	Md				N. Y	N. J.
6	Va	Cal	Tex	Conn	N. C				Va	Va.
7	Md	R. I	Ga	N. J	Penn				Me	Me.
8	N. Y	Mass	N. C	N. Y	N. J				Conn	Del.
9	Wash	Me	S. C	R. I	Mass				Oregon	Conn.
10	N. C	La	Del	Va	Me				Wash	N. C.
11	Fla	Penn	N. J	Miss					R. I	R. I.
12	R. I	Miss	Conn	S. C					Fla	Fla.
13	Conn	Tex	N. Y	Del					N. C	Oregon.
14	La	Wash		Tex					La	Wash.
15	Del	Fla		Ala					Penn	La.
16	Penn	N. C		Ga					Tex	Penn.
17	Tex	Ala		N. H					Miss	S. C.
18	S. C	Ga		Fla					Del	N. H.
19	N. H	Del		N. C					S. C	Tex.
20	Miss	S. C		Wash					N. H	Ga.
21	Ga	Oregon		Oregon					Ga	Ala.
22	Ala	N. H							Ala	Miss.

10. *Percentages of increase or decrease in 1888 as compared with* 1880.

States.	Persons employed.	Capital invested.	Value of catch.
Alabama	— 50	+ 62	— 37
California	+ 72	+ 136	+ 38
Connecticut	— 3	+ 102	+ 63
Delaware	+ 5	— 14	— 79
Florida	+ 58	+ 78	+ 25
Georgia	— 29	— 17	— 31
Louisiana	+ 135	+ 610	+ 56
Maine	+ 37	— 10	— 16
Maryland	+ 26	+ $\frac{3}{10}$	— 21
Massachusetts	— 15	— 9	— 20
Mississippi	+ 642	+ 3,646	+ 928
New Hampshire	— 13	— 49	— 49
New Jersey	+ 68	+ 4	+ 35
New York	+ 21	+ 77	— 8
North Carolina	+ 46	+ 58	— 8
Oregon	— 12	+ 176	+ 69
Pennsylvania	+ 345	+ 1,194	+ 286
Rhode Island	— 26	+ 73	+ 18
South Carolina	+ 34	+ 47	— 23
Texas	+ 70	+ 406	+ 111
Virginia	— 20	+ 24	— 20
Washington	+ 71	+ 359	+ 113
Net increase or decrease	+ 18	+ 27	— 1

Sections.	Persons employed.	Capital invested.	Value of catch.
New England States	+ 1	+ 1	— 11
Middle Atlantic States	+ 17	+ 28	— 9
South Atlantic States	+ 39	+ 54	— 5
Gulf States	+ 86	+ 245	+ 48
Pacific States	+ 28	+ 182	+ 50
Net increase or decrease	+ 18	+ 27	— 1

11. *Comparative statement by States of the catch of shad in* 1880 *and* 1888.

States.	1880.		1888.	
	Pounds.	Value.	Pounds.	Value.
Alabama	....	....	....	....
California	....	....	90,871	$6,513
Connecticut	1,318,032	$65,902	365,936	23,786
Delaware	1,050,000	52,500	1,389,216	51,999
Florida	251,700	20,136	1,448,000	89,630
Georgia	252,000	17,941	263,200	19,000
Louisiana	....	....	....	....
Maine	580,319	11,876	849,923	24,368
Maryland	3,759,426	140,326	5,595,735	218,230
Massachusetts	164,524	8,226	179,606	5,312
Mississippi	....	....	....	....
New Hampshire	6,417	321	80	3
New Jersey	750,000	35,000	6,523,447	307,411
New York	2,733,600	136,680	3,445,639	150,882
North Carolina	3,221,263	329,569	5,630,709	292,409
Oregon	....	....	10,000	500
Pennsylvania	559,600	27,980	1,387,200	76,942
Rhode Island	48,100	2,405	17,400	1,213
South Carolina	207,600	12,432	432,800	27,050
Texas	....	....	....	....
Virginia	3,171,953	134,496	8,106,823	376,944
Washington	....	....	....	....
Total	18,074,534	995,790	35,736,585	1,672,192

12. *Comparative statement by sections of the catch of shad in* 1880 *and* 1888.

Sections.	1880.		1888.	
	Pounds.	Value.	Pounds.	Value.
New England States	2, 117, 392	$88, 730	1, 412, 945	$54, 682
Middle Atlantic States	12, 024, 579	526, 982	26, 448, 060	1, 182, 408
South Atlantic States	3, 932, 563	380, 078	7, 774, 709	428, 089
Gulf States				
Pacific States			100, 871	7. 013
Total	18, 074, 534	995, 790	35, 736, 585	1, 672, 192

13. *Comparative statement by States of the catch of alewives in* 1880 *and* 1888.

States.	1880.		1888.	
	Pounds.	Value.	Pounds.	Value.
Alabama				
California				
Connecticut	770, 000	$8, 700	125, 200	$1, 253
Delaware	2, 396, 700	30, 475	941, 986	10, 925
Florida	10, 000	200		
Georgia	125, 000	3, 750	24, 360	365
Louisiana				
Maine	1, 804, 202	35, 823	3, 079, 994	30, 103
Maryland	9, 128, 959	139, 667	12, 835, 524	110, 291
Massachusetts	3, 751, 059	35, 802	6, 291, 937	83, 530
Mississippi				
New Hampshire	425, 000	8, 500	146, 750	3, 080
New Jersey	1, 200, 000	17, 335	2, 717, 520	26, 924
New York	250, 000	3, 750	223, 000	2, 676
North Carolina	15, 520, 000	142, 784	20, 463, 340	161, 673
Oregon				
Pennsylvania			811, 657	8, 365
Rhode Island	2, 978, 000	14, 460	1, 739, 300	21, 165
South Carolina	400, 000	9, 000		
Texas				
Virginia	6, 925, 413	76, 300	6, 757, 105	40, 369
Washington				
Total	45, 684, 333	526, 546	56, 157, 673	500, 713

14. *Comparative statement by sections of the catch of alewives in* 1880 *and* 1888.

Sections.	1880.		1888.	
	Pounds.	Value.	Pounds.	Value.
New England States	9, 728, 261	$103, 285	11, 383, 181	$139, 131
Middle Atlantic States	19, 901, 072	267, 527	24, 286, 792	199, 544
South Atlantic States	16, 055, 000	155, 734	20, 487, 700	162, 038
Gulf States				
Pacific States				
Total	45, 684, 333	526, 546	56, 157, 673	500, 713

15. *Comparative statement by States of the yield of oysters in* 1880 *and* 1888.

States.	1880.		1888.	
	Bushels.	Value.	Bushels.	Valu
Alabama	104, 500	$44, 950	76, 125	$32
California			130, 000	509
Connecticut	336, 450	386, 625	1, 509, 867	1, 012
Delaware	300, 000	325, 000	41, 855	17
Florida	78, 600	15, 950	239, 197	57
Georgia	70, 000	35, 000	120, 600	29
Louisiana	295, 000	200, 000	719, 992	230
Maine				
Maryland	10, 600, 000	4, 730, 476	8, 957, 058	3, 050
Massachusetts	36, 000	41, 850	45, 631	60
Mississippi	25, 000	10, 000	767, 205	157
New Hampshire	1, 000	800		
New Jersey	1, 975, 000	2, 080, 625	2, 524, 511	2, 245
New York	1, 043, 300	1, 577, 050	1, 901, 120	1, 892
North Carolina	170, 000	60, 000	204, 703	40
Oregon			4, 125	6
Pennsylvania			227, 453	163
Rhode Island	163, 200	225, 500	189, 255	252
South Carolina	50, 000	20, 000	40, 242	19
Texas	95, 625	47, 300	341, 275	109
Virginia	6, 837, 240	2, 218, 376	3, 664, 433	1, 330
Washington	15, 000	10, 000	60, 993	80
Total	22, 195, 915	12, 029, 502	21, 765, 640	11, 329

16. *Comparative statement by sections of the yield of oysters in* 1880 *and* 1888.

Sections.	1880.		1888.	
	Bushels.	Value.	Bushels.	Valu
New England States	536, 650	$654, 775	1, 744, 753	$1, 331
Middle Atlantic States	20, 755, 540	10, 931, 527	17, 316, 430	8, 714
South Atlantic States	310, 000	120, 000	423, 295	107
Gulf States	578, 725	313, 200	2, 086, 044	574
Pacific States	15, 000	10, 000	195, 118	601
Total	22, 195, 915	12, 029, 502	21, 765, 640	11, 329

III.—FISHERIES OF THE NEW ENGLAND STATES.

The length of the coast line of this section, as represented by area canvassed by the agents of the Commission, and therefore c ered by the statistics, including the rivers, is about 3,460 miles, divi as follows among the different States: Maine, 2,140; New Hampsh 35; Massachusetts, 750; Rhode Island, 245; Connecticut, 290.

The fisheries of this division are characterized by certain featu which distinguish them from all others on the Atlantic coast, nota the vessel fisheries on the ocean banks and high seas, which are great extent and vast importance. So far as the amount of capi invested and the quantity and value of the general food fish fisheries concerned, this section ranks first, although in the items of pers employed and the total quantity and value of fishery products, Middle States take precedence.

In 1888, there were engaged in the fisheries of the New England States 37,261 persons, of whom 15,612 were vessel fishermen, 11,298 shore and boat fishermen, and 10,351 shoresmen, preparators, and factory hands. The capital invested was $20,109,220, divided as follows: Vessels and outfits, $6.408,038; boats, $683,776; apparatus of capture, $1,630,532; shore property and circulating capital, $11,391,874. The value of the products at first hand was $11,074,501, of which amount nearly three-fourths represented the general food-fish products.

The series of special tables for this section, which show in more detail (by fisheries and fishing grounds) the importance of the vessel fisheries needs some little explanation. By the arrangement giving the extent of the fisheries by fishing grounds each vessel is credited to all the fisheries in which it was engaged during any portion of the year, together with its tonnage, value, and crew. It is therefore duplicated to that extent. No duplication of the catch, however, occurs. The following definitions of some of the more important fisheries recognized will add to the clearness of the tables. The other fisheries will no doubt be readily understood.

Shore fishery: Vessels engaging in this branch are mostly small craft frequenting waters adjacent to the New England shore and catching so-called ground fish, which are sold either fresh or salted.

Market fishery: Vessels credited to this fishery are of medium or large size and take fish on the banks lying to the westward (George's, Brown's, etc.) or off the New England coast. The catch consists mostly of cod, haddock, pollock, and halibut, and is landed in a fresh condition.

Halibut fishery: Vessels incidentally taking small quantities of halibut in the bank, market, and shore fisheries have not been classed under the halibut fishery, which designation has been reserved for vessels making special trips for that species and landing the fares in a fresh condition or fletched and salted.

That somewhat isolated branch of the fisheries known as the frozen-herring trade, which is engaged in by vessels from Maine and Massachusetts, can be best introduced in statistical form in this place. The table presents the leading features of the industry as prosecuted by American vessels in 1888. The vessels that engage in this trade in winter are those which at other seasons follow some other branch of fishing. The herring are purchased of the resident fishermen at a price agreed upon (which often varies) and sold for bait or food in the American markets, principally Gloucester, Boston, and New York, at rates that fluctuate materially in some seasons. The stock of a vessel is the difference between the buying and selling price. The crews are much smaller than are carried when fishing, averaging less than half as many men.

17. *Table showing the extent of the frozen-herring trade with the British Provinces in* 1888, *as carried on by American fishing vessels.*

[This table does not include the fish brought into United States territory over regular steamship lines, nor the trade maintained between various ports in the New England and Middle States.]

Where obtained.	Vessels.						Number of herring transported.	
	Number.		Net tonnage.		Value.			
	Maine.	Massachusetts.	Maine.	Massachusetts.	Maine.	Massachusetts.	Maine.	Massachusetts.
New Brunswick	4	10	129.34	645.29	$9,800	$29,532	1,282,000	*2,677,000
Nova Scotia	1		58.09		1,400		380,000	
Newfoundland		38		3,347.63		218,026		12,927,000
Total	5	48	187.43	3,992.92	11,200	247,558	1,662,000	15,604,000

*Including 150,000 fish from New Brunswick landed by vessels that also went to Newfoundland and got most of their cargo there.

MAINE.

The data here presented cover all the coast fisheries of Maine, including the rivers, which were canvassed as high as fishing was prosecuted upon a commercial basis. Thus, the St. Croix was investigated to Calais, the Penobscot to Bangor, the Sheepscot to Wiscasset, and the Kennebec to Woolwich.

In the matter of persons employed, the returns for Maine show an increase over 1880 of 4,252 in 1887 and 4,100 in 1888. There has been a small decrease in the capital invested and in the extent and value of the vessel fisheries. There has been a marked decline in the number of vessels, but the value of the fishing fleet has not materially changed, owing to the increase in the size and cost of the vessels. The general fisheries, as a rule, were quite as profitable in 1887 and 1888 as in 1880. Some branches were notably prosperous, including the lobster fishery, the pound-net and weir fishery, and the sardine industry; but the mackerel fishery was a marked failure as compared with previous years, and the meager results obtained from it made the general summation for the year much smaller than it otherwise might have been.

18. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	3,293	2,878
On transporting vessels	76	103
On transporting boats	143	149
In shore fisheries *	6,089	6,140
On shore, in canneries, factories, etc	5,722	5,901
	15,323	15,171

* Including 2,615 semi-professionals in 1887, and 2,556 in 1888.

19. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	Number.	Value.	Number.	Value.
Vessels fishing*	386	$793, 715	371	$629, 915
Outfit	....	218, 525	....	192, 569
Vessels transporting †	32	39, 350	39	59, 500
Outfit	....	6, 480	....	7, 885
Boats (not including those on vessels)	5, 537	201, 112	5, 810	209, 117
Boats transporting only	87	23, 170	97	25, 920
Apparatus of capture—vessel fisheries:				
Seines	139	69, 500	80	40, 000
Gill nets	897	9, 025	1, 057	10, 636
Trawls	1, 076	78, 537	1, 090	77, 890
Lines	4, 203	13, 824	4, 118	14, 102
Pots	4, 750	4, 750	5, 150	5. 150
Dredges	14	168	7	84
Harpoons	27	405	28	420
Rakes	34	21	28	17
Apparatus of capture—shore fisheries:				
Weirs	238	43, 280	287	55, 772
Trap nets	344	34, 045	343	33, 720
Pound nets	27	13, 125	32	14, 855
Gill nets	2, 926	27, 796	3, 271	29, 929
Seines	70	5, 795	93	7, 025
Lobster pots	109, 549	98, 061	107, 482	96, 294
Eel pots	136	153	135	148
Eel and flounder spears	313	322	283	294
Fyke nets	135	580	135	580
Bag nets	257	10, 720	280	11, 760
Hand lines and trawl lines	....	13, 590	....	13, 698
Clamming apparatus	....	1, 693	....	1, 671
Miscellaneous nets	123	408	106	357
Dredges	87	1, 131	102	1, 297
Shore property	....	779, 852	....	766, 716
Cash capital	....	690, 100	....	716, 600
Total	....	3, 179, 233	....	3, 023, 921

* Tonnage in 1887, 14,834.41; in 1888, 13,052.99. † Tonnage in 1887, 747.26; in 1888, 1,053.65.

20. *Table of products.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Mackerel, fresh	1, 486, 934	$79, 100	573, 509	$40, 703
Mackerel, salted	3, 023, 000	159, 784	1, 121, 000	73, 900
Cod, fresh	7, 790, 221	151, 630	7, 414, 181	144, 956
Cod, salted	18, 614, 702	475, 863	16, 418, 684	452, 135
Halibut, fresh	626, 807	39, 243	549, 347	34, 025
Halibut, salted	....	....	1, 000	50
Haddock, fresh	5, 567, 168	84, 192	5, 693, 979	94, 422
Haddock, salted	1, 666. 748	22, 644	1, 482, 498	21, 556
Hake, fresh	3, 104, 258	28, 480	2, 993, 637	26, 251
Hake, salted	5, 478, [illegible]	62, 545	5, 977, 041	74, 904
Pollock, fresh	692, 843	7, 043	922, 303	9, 474
Pollock, salted	995, 395	10, 413	1, 226, 570	12, 943
Cusk, fresh	456, 046	5, 288	442, 582	5, 372
Cusk, salted	110, 041	1, 099	136, 059	1, 412
Red snapper, fresh	129, 500	4, 069	188, 809	5, 238
Grouper, fresh	8, 400	231	16, 500	462
Herring, fresh	23, 916, 855	96, 239	28, 994, 454	112, 008
Herring, salted	3, 731, 800	37, 346	4, 928, 000	54, 626
Herring, smoked	2, 012, 800	67, 030	2, 207, 745	73, 315
Alewives, fresh	897, 042	7, 435	974, 399	8, 343
Alewives, salted	779, 960	13, 581	915, 450	14, 319
Alewives, smoked	229, 279	7, 149	241, 140	7, 441
Menhaden, fresh	702, 000	1, 705	3, 121, 200	14, 001
Menhaden, salted	....	....	2, 000	18
Shad, fresh	1, 087, 720	27, 010	807, 256	22, 868
Shad, salted	8, 000	320	32, 000	1, 500
Cunners or perch, fresh	52, 200	1, 665	71, 647	2, 058
Flounders, fresh	658, 525	11, 778	828, 995	15, 590
Eels, fresh	107, 285	9, 105	127, 140	10, 090
Swordfish, fresh	234, 721	10, 679	440, 523	18, 691
Salmon, fresh	185, 637	36, 398	205, 149	41, 209
Smelt, fresh	1, 205. 150	87, 977	1, 279, 550	94, 927

20. *Table of products*—Continued.

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Tomcod or frostfish, fresh	477, 300	$3, 309	474, 560	$3, 772
Butterfish, fresh	5, 000	75	22, 000	360
Bream (*Sebastes marinus*), fresh	25, 000	255	26, 000	270
Catfish (*Anarrhichas*), fresh	6, 000	120	6, 200	124
Wastefish, fresh	484, 000	1, 782	446, 200	1, 785
Clams (soft), fresh	1, 886, 540	75, 536	1, 863, 950	76, 665
Clams (soft), salted	4, 201, 260	152, 954	4, 142, 800	151, 000
Quohaugs, fresh	800	100	800	100
Scallops, fresh	221, 132	13, 994	180, 006	11, 278
Mussels, fresh	6, 450	189	6, 540	193
Lobsters, fresh	22, 915, 642	512, 044	21, 694, 731	515, 880
Tongues (cod)	267, 630	6, 022	232, 812	4, 646
Sounds (cod and hake, green)	113, 618	22, 733	118, 941	9, 516
Oil (fish, whale, porpoise, and seal)	679, 110	21, 586	676, 707	21, 432
Seaweed	14, 500, 000	7, 115	12, 700, 000	6, 215
Total	131, 379, 591	2, 364, 906	132, 929, 594	2, 292, 043

21. *Summary by customs districts of the vessel fisheries of Maine in* 1887 *and* 1888.

FISHING VESSELS.

Customs districts.	No. of vessels.		Net tonnage.		Value of vessels.		Value of apparatus and outfit.		No. of fishermen.		Value of catch.*	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
Passamaquoddy	8	6	254. 73	141. 95	$17, 600	$7, 000	$6, 475	$2, 850	66	40	$12, 520	$5, 210
Machias	17	23	298. 41	335. 98	8, 375	10, 100	6, 080	6, 670	87	101	13, 424	14, 978
Frenchman's Bay	31	38	1, 668. 00	1, 846. 15	80, 775	72, 925	50, 370	58, 855	306	348	115, 477	125, 451
Castine	48	53	2, 165. 52	2, 091. 29	87, 900	75, 300	67, 990	59, 710	436	417	125, 948	139, 163
Belfast	30	23	1, 208. 15	761. 74	58, 750	35, 925	30, 445	18, 675	293	194	50, 159	39, 282
Waldoborough	78	75	1, 662. 82	1, 489. 34	75, 731	60, 085	33, 105	27, 880	397	384	117, 174	104, 515
Wiscasset	39	35	1, 699. 73	1, 594. 36	105, 600	99, 075	50, 825	48, 730	399	355	118, 514	88, 112
Bath	7	6	104. 46	92. 71	3, 859	2, 655	2, 765	1, 450	31	23	5, 394	4, 632
Portland	113	98	5, 563. 88	4, 499. 80	340, 225	257, 025	136, 899	108, 025	1, 197	949	377, 741	311, 930
Saco	5	3	80. 27	24. 35	7, 250	1, 775	3, 408	1, 575	27	14	12, 373	4. 100
Kennebunk	8	9	152. 62	159. 41	7, 150	7, 550	6, 118	6, 168	48	48	22, 224	16, 638
York	2	2	15. 82	15. 82	500	500	275	280	6	5	705	1, 101
Total	386	371	14, 834. 41	13, 052. 99	793, 715	629, 915	394, 755	340, 868	3, 293	2, 878	971, 653	855, 112

* In addition to the values given, $32,779 in 1887 and $23,149 in 1888 should be added for oil, cod tongues, and sounds.

TRANSPORTING VESSELS.

Customs districts.	No. of vessels.		Net tonnage.		Value of vessels.		Value of outfit.		No. of fishermen.	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
Passamaquoddy	12	16	317. 05	628. 13	$13, 950	$30, 250	$2, 850	$3, 140	31	51
Machias	2	3	17. 31	26. 96	6, 000	9, 000	900	1, 470	4	7
Frenchman's Bay	3	1	156. 11	51. 91	3, 400	800	425	225	8	3
Castine	4	5	43. 47	65. 65	7, 200	7, 350	1, 300	1, 275	9	11
Belfast	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Waldoborough	7	6	140. 66	120. 94	5, 900	5, 000	675	550	16	14
Wiscasset	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bath	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Portland	4	8	72. 66	160. 06	2, 900	7, 100	600	1, 225	8	17
Saco	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kennebunk	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
York	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	32	39	747. 26	1, 053. 65	39, 350	59, 500	6, 480	7, 885	76	103

22. *Table showing by customs districts the number and nationality of the vessel fishermen of Maine.*

Customs districts.	1887.				1888.			
	Americans.	British provincials.	All others.	Total.	Americans.	British provincials.	All others.	Total.
Fishing vessels.								
Passamaquoddy	56	10	...	66	36	4	...	40
Machias	87	...	...	87	101	...	...	101
Frenchman's Bay	236	69	1	306	273	71	4	348
Castine	409	26	1	436	386	31	...	417
Belfast	248	43	2	293	178	13	3	194
Waldoborough	396	1	...	397	373	7	4	384
Wiscasset	304	95	...	399	245	...	110	355
Bath	31	...	...	31	23	...	...	23
Portland	1,042	70	85	1,197	809	122	18	949
Saco	22	5	...	27	14	...	...	14
Kennebunk	47	...	1	48	48	...	...	48
York	6	...	...	6	5	...	...	5
Total	2,884	319	90	3,293	2,491	248	139	2,878
Transporting vessels.								
Passamaquoddy	29	2	...	31	48	3	...	51
Machias	4	...	...	4	7	...	...	7
Frenchman's Bay	8	...	...	8	3	...	...	3
Castine	9	...	...	9	11	...	...	11
Belfast	...	...	...	...	...	...	...	...
Waldoborough	16	...	...	16	14	...	...	14
Wiscasset	...	...	...	...	...	...	...	...
Bath	...	...	...	...	...	...	...	...
Portland	8	...	...	8	17	...	...	17
Saco	...	...	...	...	...	...	...	...
Kennebunk	...	...	...	...	...	...	...	...
York	...	...	...	...	...	...	...	...
Total	74	2	...	76	100	3	...	103
Grand total	2,958	321	90	3,369	2,591	251	139	2,981

23. *Table showing by species and customs districts the yield of the vessel fisheries of Maine.*

Species.	Passamaquoddy.		Machias.		Frenchman's Bay.		Castine.	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Mackerel, fresh	...	...	...	...	...	3,300	...	...
Mackerel, salted	31,000	...	...	...	1,600	...	428,800	194,200
Cod, fresh	225,000	...	29,556	27,232	10,200	58,000	4,571	6,450
Cod, salted	198,800	59,250	275,179	233,795	3,803,089	3,205,139	3,048,638	3,240,013
Halibut, fresh	4,000	4,500	13,800	16,120	21,100	42,305	15,071	...
Halibut, salted	...	...	...	...	...	...	...	1,000
Haddock, fresh	...	...	1,000	16,600	9,135	12,135	16,300	1,600
Haddock, salted	5,000	...	30,886	20,384	20,500	32,800	89,929	105,071
Hake, fresh	...	...	15,110	1,000	...	3,500	600	5,700
Hake, salted	55,000	...	154,910	221,953	394,670	604,304	287,694	592,871
Pollock, salted	18,400	...	37,921	29,814	138,047	176,560	21,000	110,200
Cusk, salted	...	...	167	...	48,000	44,000	...	...
Herring, fresh	67,000	...	10,000	10,000	12,500	46,000	13,000	9,600
Herring, salted	...	380,000	64,400	221,000	80,800	144,000	163,400	413,400
Lobsters, fresh	...	...	96,978	90,300	10,560	12,400	13,200	1,400
Clams, fresh	...	...	70	4,580	180	...	...	...
Scallops, fresh	...	...	...	...	30,875	1,188	59,850	13,272
Total	604,200	443,750	729,977	892,778	4,581,256	4,385,631	4,162,053	4,694,777

23. *Table showing by species and customs districts the yield of the vessel fisheries of Maine*—Continued.

Species.	Belfast.		Waldoborough.		Wiscasset.		Bath.	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Mackerel, fresh	11, 500	...	182, 800	141, 560	110, 000	22, 000	1, 500	...
Mackerel, salted	417, 800	159, 400	19, 400	3, 400	414, 800	124, 000	...	...
Cod, fresh	163, 875	560, 373	352, 320	413, 150	165, 949	241, 049	134, 353	21, 190
Cod, salted	479, 865	723, 100	1, 479, 036	745, 420	3, 093, 119	2, 380, 101	58, 513	82, 674
Halibut, fresh	5, 300	110	137, 571	45, 100	14, 485	16, 815	4, 172	2, 200
Haddock, fresh	263, 075	53, 087	83, 214	272, 917	258, 127	454, 473	25, 206	11, 100
Haddock, salted	127, 661	107, 500	309, 381	139, 983	3, 000	3, 000	15, 208	9, 608
Hake, fresh	...	...	528, 007	460, 122	...	...	22, 500	...
Hake, salted	747, 515	550, 700	1, 449, 502	1, 524, 283	120, 436	175, 916	40, 609	23, 641
Pollock, fresh	...	...	...	7, 000	...	...	...	...
Pollock, salted	15, 950	3, 000	111, 341	33, 633	92, 500	182, 000	26, 408	24, 460
Cusk, salted	...	...	28, 400	55, 000	...	...	...	...
Herring, fresh	11, 725	...	181, 000	139, 400	...	...	2, 400	...
Herring, salted	81, 600	137, 000	1, 584, 200	1, 300, 200	128, 000	429, 000	1, 000	30, 000
Menhaden, fresh	...	...	...	344, 000	...	1, 200, 000	...	...
Menhaden, salted	...	...	...	2, 000	...	...	...	...
Alewives, fresh	...	...	...	5, 000	...	...	...	...
Alewives, salted	...	...	...	4, 600	...	...	...	...
Eels, fresh	...	...	...	...	...	...	8, 000	4, 000
Swordfish, fresh	...	5, 100	...	52, 000	...	...	...	...
Lobsters, fresh	...	12, 000	206, 302	153, 122	14, 000	7, 000	...	...
Clams, fresh	670	200	2, 750	770	19, 160	13, 080	180	...
Total	2, 326, 536	2, 311, 570	6, 655, 224	5, 842, 660	4, 433, 576	5, 248, 434	340, 049	208, 873

Species.	Portland.		Saco.		Kennebunk.		York.	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Mackerel, fresh	700, 272	137, 841	2, 500	...	3, 242	13, 658	...	...
Mackerel, salted	1, 709, 600	640, 000	...	...	...	...	...	...
Cod, fresh	3, 349, 762	3, 329, 174	142, 467	41, 900	723, 404	305, 928	15, 600	13, 000
Cod, salted	4, 574, 411	3, 946, 953	2, 883	...	174, 611	292, 944	...	...
Halibut, fresh	267, 252	278, 402	...	...	2, 171	...	...	...
Haddock, fresh	2, 056, 888	2, 303, 440	193, 000	1, 400	141, 428	70, 293	3, 500	27, 000
Haddock, salted	278, 792	285, 447	...	...	17, 500	26, 917	...	...
Hake, fresh	492, 798	343, 233	...	...	23, 282	58, 417	2, 800	...
Hake, salted	558, 663	560, 125	...	...	162, 176	137, 455	...	...
Pollock, fresh	8, 500	119, 540	...	...	...	...	...	...
Pollock, salted	227, 776	326, 343	3, 130	...	5, 978	7, 300	...	...
Cusk, fresh	98, 200	118, 632	...	...	...	...	...	...
Cusk, salted	6, 588	...	...	...	...	...	...	...
Red snapper, fresh	129, 500	188, 809	...	...	...	...	...	...
Grouper, fresh	8, 400	16, 500	...	...	...	...	...	...
Herring, fresh	88, 050	33, 625	875	200	12, 000	48, 000	20, 125	23, 000
Herring, salted	171, 800	194, 000	...	...	26, 600	4, 000	3, 600	6, 600
Menhaden, fresh	700, 000	18, 200	...	...	...	8, 000	...	...
Shad, salted	8, 000	32, 000	...	...	...	...	...	...
Cunners, fresh	...	19, 247	...	...	...	...	...	...
Eels, fresh	...	19, 000	...	...	...	...	...	...
Swordfish, fresh	175, 538	337, 073	29, 300	8, 350	29, 883	38, 000	...	...
Lobsters, fresh	9, 070	15, 524	151, 304	92, 000	7, 414	41, 166	...	...
Clams, fresh	11, 010	7, 800	...	...	...	12, 800	700	900
Mussels, fresh	450	340	...	...	...	...	...	...
Total	15, 631, 320	13, 271, 248	525, 459	143, 850	1, 329, 689	1, 064, 878	46, 325	70, 500

23. *Table showing by species and customs districts the yield of the vessel fisheries of Maine*—Continued.

Species.	Total pounds.		Total value.	
	1887.	1888.	1887.	1888.
Mackerel, fresh	1, 011, 814	318, 359	$54, 809	$22, 517
Mackerel, salted	3, 023, 000	1, 121, 000	159, 784	73, 900
Cod, fresh	5, 317, 057	5, 017, 446	104, 220	98, 680
Cod, salted	17, 188, 144	14, 909, 389	439, 609	413, 227
Halibut, fresh	484, 922	405, 552	30, 473	25, 992
Halibut, salted	....	1, 000	....	50
Haddock, fresh	3, 050, 873	3, 224, 045	44, 668	54, 099
Haddock, salted	897, 857	730, 710	9, 444	8, 456
Hake, fresh	1, 085, 097	871, 972	9, 971	7, 550
Hake, salted	3, 971, 175	4, 391, 248	42, 957	54, 289
Pollock, fresh	8, 500	126, 540	106	1, 275
Pollock, salted	698, 451	893, 310	6, 850	8, 943
Cusk, fresh	98, 200	118, 632	884	1, 000
Cusk, salted	83, 155	99, 000	807	1, 000
Red snapper, fresh	129, 500	188, 809	4, 069	5, 238
Grouper, fresh	8, 400	16, 500	231	462
Herring, fresh	418, 675	309, 825	3, 504	2, 144
Herring, salted	2, 305, 400	3, 259, 200	24, 042	36, 796
Menhaden, fresh	700, 000	1, 570, 200	1, 750	3, 017
Menhaden, salted	....	2, 000	....	18
Alewives, fresh	....	5, 000	....	25
Alewives, salted	....	4, 600	....	34
Shad, salted	8, 000	32, 000	320	1, 500
Cunners, fresh	....	19, 247	....	385
Eels, fresh	8, 000	23, 000	480	1, 380
Swordfish, fresh	234, 721	440, 523	10, 679	18, 691
Lobsters, fresh	508, 828	424, 912	16, 401	12, 360
Clams, fresh	34, 720	40, 130	823	1, 327
Scallops, fresh	90, 725	14, 460	4, 763	750
Mussels, fresh	450	340	9	7
Total	41, 365, 664	38, 578, 949	971, 653	855, 112

The above table does not include the following secondary products: In 1887—407,805 pounds of oil, $13,641; 66,604 pounds of hake sounds, $13,330; 258,120 pounds of cod tongues, $5,808. In 1888—391,007 pounds of oil, $13,143; 69,508 pounds of hake sounds, $5,561; 222,750 pounds of cod tongues, $4,445.

24. *Table showing by species the products of the vessel fisheries of Maine.*

Species.	1887.				1888.			
	Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mackerel	1, 011, 814	$54, 809	3, 023, 000	$159, 784	318, 359	$22, 517	1, 121, 000	$73, 900
Cod	5, 317, 057	104, 220	17, 188, 144	439, 609	5, 076, 696	99, 865	14, 850, 139	412, 042
Halibut	484, 922	30, 473	....	....	405, 552	25, 992	1, 000	50
Herring	418, 675	3, 504	2, 305, 400	24, 042	309, 825	2, 144	3, 259, 200	36, 796
Haddock	3, 050, 873	44, 668	897, 857	9, 444	3, 224, 045	54, 099	730, 710	8, 456
Pollock	8, 500	106	698, 451	6, 850	126, 540	1, 275	893, 310	8, 943
Hake	1, 085, 097	9, 971	3, 971, 175	42, 957	871, 972	7, 550	4, 391, 248	54, 289
Cusk	98, 200	884	83, 155	807	118, 632	1, 000	99, 000	1, 000
Swordfish	234, 721	10, 679	....	....	440, 523	18, 691	....	....
Eels	8, 000	480	....	....	23, 000	1, 380	....	....
Shad	....	....	8, 000	320	....	....	32, 000	1, 500
Menhaden	700, 000	1, 750	....	....	1, 570, 200	3, 017	2, 000	18
Red snapper	129, 500	4, 069	....	....	188, 809	5, 238	....	....
Grouper	8, 400	231	....	....	16, 500	462	....	....
Alewives	....	....	....	....	5, 000	25	4, 600	34
Cunners or perch	....	....	....	....	19 247	385	....	....
Lobsters	508, 828	16, 401	....	....	424, 912	12, 360	....	....
Scallops	90, 725	4, 763	....	....	14, 460	750	....	....
Clams (soft)	34, 720	823	....	....	40, 130	1, 327	....	....
Mussels	450	9	....	....	340	7	....	....
Hake sounds	66, 654	13, 330	....	....	69, 508	5, 561	....	....
Tongues	258, 120	5, 808	....	....	222, 750	4, 445	....	....
Oil	407, 805	13, 641	....	....	391, 007	13, 143	....	....
Total	13, 923, 061	320, 619	28, 175, 182	683, 813	13, 878, 007	281, 233	25, 384, 207	597, 028

25. *Table showing by apparatus and species the products of the vessel fisheries of Maine.*

[The weights given represent the fish, etc., as sold, regardless of the condition in which marketed.]

Apparatus and species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Hand lines and trawls:				
Mackerel	21,600	$1,152	5,300	$371
Cod	22,495,201	543,654	19,914,935	511,698
Halibut	484,922	30,473	406,552	26,042
Haddock	3,948,730	54,112	3,954,755	62,555
Hake	5,056,272	52,928	5,263,220	61,839
Pollock	706,951	6,956	1,019,850	10,218
Cusk	181,355	1,691	217,632	2,000
Red snapper	129,500	4,069	188,809	5,238
Grouper	8,400	231	16,500	462
Swordfish	6,000	270	11,000	452
Total	33,038,931	695,536	30,998,553	680,875
Purse seines:				
Mackerel	3,615,372	192,223	1,180,041	79,535
Menhaden	700,000	1,750	1,572,200	3,035
Shad	8,000	320	32,000	1,500
Total	4,323,372	194,293	2,784,241	84,070
Gill nets:				
Mackerel	397,842	21,218	254,018	16,511
Cod	10,000	175	11,900	209
Herring	2,724,075	27,546	3,569,025	38,940
Alewives	....	....	9,600	59
Cunners	....	....	19,247	385
Total	3,131,917	48,939	3,863,790	56,104
Traps and pots:				
Eels	8,000	480	23,000	1,380
Lobsters	508,828	16,401	424,912	12,360
Total	516,828	16,881	447,912	13,740
Harpoons:				
Swordfish	228,721	10,409	429,523	18,239
Dredges and rakes:				
Clams	34,720	823	40,130	1,327
Mussels	450	9	340	7
Scallops	90,725	4,763	14,460	750
Total	125,895	5,595	54,930	2,084
Grand total	41,365,664	971,653	38,578,949	855,112

26. *Table showing the number of vessels engaged in each fishery in Maine, in* 1888, *together with their tonnage, value, and number of crew.*

Fishery	No. of vessels engaged.	Net tonnage.	Value of vessels.	Number and nationality of fishermen.			
				Americans.	British provincials.	All others.	Total.
Cod on banks, east of 65° W. longitude	66	5,350.06	$247,400	730	269	5	1,004
Halibut	4	348.29	28,000	43	10	5	58
Mackerel, Gulf of St. Lawrence	7	512.13	35,300	97	14	1	112
Mackerel, New England shore	65	2,595.75	162,575	471	62	37	570
Shore	211	4,498.86	194,115	993	44	3	1,040
Market	35	2,013.86	116,200	349	63	....	412
Herring	118	2,281.16	79,000	418	8	....	426
Swordfish	24	751.25	38,600	155	16	....	171
Menhaden	5	184.08	11,200	41	....	....	41
Clam	19	330.52	13,725	93	....	....	93
Scallop	3	41.68	1,140	14	....	....	14
Mussel	2	74.31	4,500	17	....	....	17
Lobster	28	370.34	13,050	98	....	....	98

27. *Table showing by fisheries and species the yield of the vessel fisheries of Maine in* 1888.

[This table does not include 391,007 pounds of oil, valued at $13,143; 69,568 pounds of hake sounds, valued at $5,561; 222,750 pounds of tongues, valued at $4,445.]

Fisheries and species.	Pounds.	Value.
Shore:		
Alewives	5, 000	$25
Alewives, salted	4, 600	34
Cod	2, 244, 673	43, 226
Cod, salted	4, 246, 618	95, 548
Cunners	19, 247	385
Cusk	118, 632	1, 000
Cusk, salted	99, 000	1, 000
Eels	23, 000	1, 380
Haddock	1, 137, 442	20, 084
Haddock, salted	704, 846	8, 160
Hake	871, 972	7, 550
Hake, salted	4, 361, 448	53, 917
Halibut	97, 018	5, 820
Halibut, salted	1, 000	50
Herring	7, 000	56
Pollock	126, 540	1, 275
Pollock, salted	774, 972	7, 760
Menhaden, salted	2, 000	18
Shad, salted	32, 000	1, 500
Total	14, 877, 008	248, 788
Mackerel:		
Mackerel	318, 359	22, 517
Mackerel, salted	1, 121, 000	73, 900
Total	1, 439, 359	96, 417
Bank:		
Cod, salted	10, 454, 271	312, 988
Haddock, salted	864	10
Halibut	4, 500	315
Total	10, 459, 635	313, 313
Market:		
Cod	2, 772, 773	$55, 454
Cod, salted	208, 500	4, 691
Grouper	16, 500	462
Haddock	2, 086, 603	34, 015
Haddock, salted	25, 000	286
Hake, salted	29, 800	372
Halibut	32, 754	2, 292
Pollock, salted	118, 338	1, 183
Red snapper	188, 809	5, 238
Total	5, 479, 077	103, 993
Halibut	271, 280	17, 565
Menhaden	1, 570, 200	3, 017
Swordfish	440, 523	18, 691
Herring:		
Herring	302, 825	2, 088
Herring, salted	3, 259, 200	36, 796
Total	3, 562, 025	38, 884
Mollusk:		
Mussels	340	7
Clams	40, 130	1, 327
Scallops	14, 460	750
Total	54, 930	2, 084
Crustacean:		
Lobsters	424, 912	12, 360
Grand total	38, 578, 949	855, 112

28. *Table showing by fishing grounds the catch of the mackerel (by apparatus) and bank cod fleets of Maine in* 1888.

Fishery.	New England shore.		Gulf of St. Lawrence.		East of 65° W. longitude.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mackerel caught with seines:								
Fresh	107, 841	$7, 549					107, 841	$7, 549
Salted	927, 400	59, 613	162, 200	$12, 165			1, 089, 600	71, 778
Mackerel caught with nets:								
Fresh	210, 518	14, 968					210, 518	14, 968
Salted	8, 200	498					8, 200	498
Mackerel caught with lines:								
Salted	23, 200	1, 624					23, 200	1, 624
Cod, salted					10, 454, 271	$312, 988	10, 454, 271	312, 988
Total	1, 277, 159	84, 252	162, 200	12, 165	10, 454, 271	312, 988	11, 893, 630	409, 405

29. *Table showing by species the products of the shore fisheries of Maine.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Mackerel, fresh	475, 120	$24, 291	255, 150	$18, 186
Cod, fresh	2, 473, 164	47, 410	2, 396, 735	46, 276
Cod, salted	1, 426, 558	36, 254	1, 509, 295	38, 908
Hake, fresh	2, 019, 161	18, 509	2, 121, 665	18, 701
Hake, salted	1, 506, 897	19, 588	1, 585, 793	20, 615
Haddock, fresh	2, 516, 295	39, 524	2, 469, 934	40, 323
Haddock, salted	768, 891	13, 200	751, 788	13, 100
Cusk, fresh	357, 846	4, 404	323, 950	4, 372
Cusk, salted	26, 886	292	37, 059	412
Pollock, fresh	684, 343	6, 937	795, 763	8, 199
Pollock, salted	296, 944	3, 563	333, 260	4, 000
Halibut, fresh	141, 885	8, 770	143, 795	8, 033
Herring, fresh	23, 528, 180	92, 735	28, 684, 629	109, 864
Herring, pickled	1, 426, 400	13, 304	1, 668, 800	17, 830
Herring, smoked	2, 012, 800	67, 030	2, 207, 745	73, 315
Alewives, fresh	897, 042	7, 435	969, 399	8, 318
Alewives, pickled	779, 960	13, 581	910, 850	14, 285
Alewives, smoked	229, 279	7, 140	244, 140	7, 441
Menhaden, fresh	2, 000	15	1, 551, 000	10, 984
Shad, fresh	1, 087, 720	27, 010	807, 256	22, 868
Smelt, fresh	1, 205, 150	87, 977	1, 279, 550	94, 927
Tomcod or frostfish, fresh	477, 300	3, 309	474, 560	3, 772
Cunners or perch, fresh	52, 200	1, 665	52, 400	1, 673
Salmon, fresh	185, 637	36, 398	205, 149	41, 209
Eels, fresh	99, 285	8, 625	104, 140	8, 710
Flounders, fresh	658, 525	11, 778	828, 995	15, 590
Butterfish, fresh	5, 000	75	22, 000	360
Bream, fresh	25, 000	255	26, 000	270
Catfish, fresh	6, 000	120	6, 200	124
Waste or refuse fish, fresh	484, 000	1, 782	446, 200	1, 785
Lobsters, fresh	22, 407, 814	495, 643	21, 269, 819	503, 520
Clams (soft), fresh	1, 851, 820	74, 713	1, 823, 820	75, 338
Clams (soft), salted	4, 201, 260	152, 954	4, 142, 800	151, 000
Quohaugs, fresh	800	100	800	100
Scallops, fresh	130, 407	9, 231	165, 546	10, 528
Mussels, fresh	6, 000	180	6, 200	186
Oil (fish, whale, porpoise, and seal)	271, 305	7, 945	285, 700	8, 289
Hake and cod sounds, green	47, 014	9, 403	49, 433	3, 955
Cod tongues	9, 510	214	10, 062	201
Seaweed	14, 500, 000	7, 115	12, 700, 000	6, 215
Total	89, 281, 398	1, 360, 474	93, 667, 380	1, 413, 782

30. *Table showing by apparatus and species the yield of the shore fisheries of Maine in 1887, exclusive of the shellfish and lobster fisheries.*

Apparatus and species.	Pounds.	Value.
Hand lines and trawl lines:		
Mackerel	90, 000	$4, 300
Cod	2, 370, 014	45, 042
Cod, salted	1, 426, 558	36, 254
Haddock	2, 516, 295	39, 524
Haddock, salted	768, 891	13, 200
Hake	2, 019, 161	18, 509
Hake, salted	1, 506, 897	19, 588
Pollock	627, 343	6, 823
Pollock, salted	296, 944	3, 563
Cusk	357, 846	4, 404
Cusk, salted	26, 886	292
Halibut	141, 885	8, 770
Cunners	17, 200	640
Flounders	10, 000	160
Bream	25, 000	255
Catfish	6, 000	120
Smelt	589, 105	43, 223
Total	12, 796, 025	244, 667
Gill nets:		
Mackerel	73, 100	4, 595
Cod	100, 150	2, 303
Shad	528, 020	12, 976
Herring	2, 066, 720	12, 641
Herring, salted	1, 426, 400	13, 304
Herring, smoked	25, 500	690
Salmon	2, 374	925
Total	4, 222, 264	47, 434

Apparatus and species.	Pounds.	Value.
Seines:		
Mackerel	4, 000	$240
Flounders	286, 500	5, 199
Smelt	142, 300	9, 640
Herring	23, 000	200
Waste and refuse fish	104, 000	520
Total	559, 800	15, 799
Weirs, pound nets, and trap nets:		
Mackerel	308, 020	15, 156
Cod	3, 000	65
Pollock *	57, 000	114
Cunners	35, 000	1, 025
Flounders	5, 000	75
Smelt	79, 650	3, 437
Menhaden	2, 000	15
Shad	559, 700	14, 034
Herring †	21, 438, 460	79, 894
Herring, smoked	1, 987, 300	66, 340
Alewives	667, 167	6, 181
Alewives, salted	30, 360	505
Alewives, smoked	101, 503	3, 390
Salmon	182, 913	35, 416
Tomcod or frostfish	24, 100	40
Butterfish	5, 000	75
Waste and refuse fish	240, 000	1, 000
Total	25, 726, 173	226, 762

* Mostly waste fish.

† Including the quantity subsequently canned.

30. *Table showing by apparatus and species the yield of the shore fisheries of Maine in 1887, exclusive of the shellfish and lobster fisheries*—Continued.

Apparatus and species.	Pounds.	Value.
Bag nets:		
Flounders	27, 050	$788
Smelt	388, 145	31, 422
Frostfish or tomcod	446, 700	3, 234
Waste and refuse fish	140, 000	262
Total	1, 001, 895	35, 706
Fyke nets:		
Flounders	110, 000	1, 177
Smelt	3, 600	184
Frostfish or tomcod	2, 500	10
Total	116, 100	1, 371
Pots:		
Eels	20, 350	1, 522
Dip nets:		
Smelt	2, 350	$71
Alewives	212, 500	1, 104
Alewives, salted	749, 600	13, 076
Alewives, smoked	107, 464	3, 126
Salmon	350	57
Frostfish or tomcod	4, 000	25
Total	1, 076 264	17, 459
Spears:		
Flounders	219, 975	4, 379
Eels	78, 935	7, 103
Total	298, 910	11, 482
Grand total	45, 817, 781	602, 202

31. *Table showing by apparatus and species the yield of the shore fisheries of Maine in 1888, exclusive of the shellfish and lobster fisheries.*

Apparatus and species.	Pounds.	Value.
Hand lines and trawl lines:		
Mackerel	47, 400	$3, 450
Cod	2, 356, 035	45, 417
Cod, salted	1, 509, 295	38, 908
Haddock	2, 469, 934	40, 323
Haddock, salted	751, 788	13, 100
Hake	2, 121, 665	18, 701
Hake, salted	1, 585, 793	20, 615
Pollock	732, 763	8, 073
Pollock, salted	333, 260	4, 000
Cusk	323, 950	4, 372
Cusk, salted	37, 059	412
Halibut	143, 795	8, 033
Cunners	17, 500	650
Flounders	10, 800	172
Bream	26, 000	270
Catfish	6, 200	124
Smelt	601, 812	47, 394
Total	13, 075, 049	254, 014
Gill nets:		
Mackerel	44, 040	3, 646
Cod	28, 200	604
Menhaden	1, 518, 600	10, 691
Shad	278, 272	7, 460
Herring	1, 812, 965	11, 519
Herring, salted	1, 668, 800	17, 830
Herring, smoked	18, 000	540
Salmon	2, 282	934
Total	5, 371, 159	53, 224
Seines:		
Mackerel	1, 000	75
Flounders	455, 150	8. 907
Smelt	179, 600	11, 366
Herring	8, 000	70
Waste and refuse fish	105, 000	525
Total	748, 750	20, 943
Bag nets:		
Flounders	29, 970	857
Smelt	397, 538	31, 696
Frostfish or tomcod	432, 860	3, 642
Waste and refuse fish	142, 800	268
Total	1, 003, 168	36, 463
Weirs, pound nets, and trap nets:		
Mackerel	162, 710	$11, 015
Cod	12, 500	255
Pollock*	63, 000	126
Cunners	34, 900	1, 023
Flounders	5, 000	75
Smelt	93, 600	4, 156
Menhaden	32, 400	293
Shad	528, 984	15, 408
Herring†	26, 863, 664	98, 275
Herring, smoked	2, 189, 745	72, 775
Alewives	632. 829	6, 332
Alewives, salted	20, 550	370
Alewives, smoked	133, 525	4, 379
Salmon	202, 692	40, 246
Frostfish or tomcod	25, 200	55
Butterfish	22, 000	360
Waste and refuse fish	198, 400	992
Total	31, 221, 699	256, 135
Dip nets:		
Smelt	2, 000	75
Alewives	350, 070	1, 986
Alewives, salted	890, 300	13, 915
Alewives, smoked	110, 615	3, 062
Salmon	175	29
Frostfish or tomcod	4, 000	25
Total	1, 357, 160	19, 092
Fyke nets:		
Flounders	106, 000	1, 217
Smelt	5, 000	240
Frostfish or tomcod	12, 500	50
Total	123, 500	1, 507
Pots:		
Eels	23, 340	1, 650
Spears:		
Flounders	222, 075	4, 362
Eels	80, 800	7, 060
Total	302, 875	11, 422
Grand total	53, 226, 700	654, 450

*Mostly waste fish. †Including the quantity subsequently canned.

NEW HAMPSHIRE.

There has been a considerable diminution in the fisheries of this State in persons employed, the amount of capital invested, and the quantity and value of products. Fishing, however, has never been an important industry of the State, as compared with Maine and Massachusetts, because of its short coast line. Portsmouth and New Castle are the only fishing centers of any importance.

The decrease has been wholly in the vessel fishery, there having been only 12 vessels in 1887 and 14 in 1888, against 23 in 1880. There has been an increase of 30 men in the boat fishery, but as no separate figures were given of capital and products for the shore fishery in 1880 there is no basis for comparison of these items.

In 1880 the total catch was 10,400,294 pounds, valued at $176,684, while in 1888 it reached 3,843,479 pounds, worth $90,044.

32. *Table of persons employed.*

How engaged.	1887.	1888.
In vessel fisheries	108	132
In shore fisheries	197	197
On shore	41	33
Total	346	362

33. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels *	12	$26,550	14	$27,150
Outfit		9,470		9,901
Boats	75	4,220	75	4,220
Apparatus of capture—vessel fisheries:				
Purse seines	5	2,600	5	2,730
Hand and trawl lines		10,975		12,502
Gill nets	35	420	45	540
Harpoons	7	105	10	150
Lobster pots	250	350	225	325
Apparatus of capture—shore fisheries:				
Haul seines	3	150	3	135
Gill nets	95	1,150	107	1,246
Pound nets	1	1,000	1	1,000
Weirs	10	750	12	860
Lobster pots	2,045	2,510	2,065	2,540
Hand and trawl lines		840		825
Spears, clamming outfits, etc		20		20
Shore property		40,000		38,000
Cash capital		5,000		5,000
Total		106,110		107,144

* Tonnage in 1887, 415.57; in 1888, 498.42.

34. *Table of products.*

Species.	Vessel fisheries.				Shore fisheries.			
	1887.		1888.		1887.		1888.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives					100, 450	$1, 960	146, 750	$3, 080
Cod, fresh	1, 428, 622	$28, 901	892, 582	$18, 968	486, 600	8, 010	458, 000	7, 695
Cod, salted	120, 313	3, 007	75, 197	1, 881				
Eels					10, 000	1, 000	10, 000	1, 100
Haddock, fresh	351, 746	6, 255	407, 498	8, 150	646, 000	10, 445	652, 000	10, 650
Haddock, salted	11, 313	226	9, 697	194				
Hake, fresh	176, 787	1, 500	209, 992	1, 880				
Hake, salted	11, 613	140	9, 700	121				
Halibut, fresh	155, 777	11, 756	143, 467	11, 577				
Herring, fresh			60, 000	600	77, 000	680	148, 000	1, 260
Herring, salted	10, 000	113						
Herring, etc., for bait					136, 000	1, 000	150, 200	1, 200
Mackerel, fresh	140, 817	8, 449	53, 116	3, 718	3, 560	400	3, 500	400
Mackerel, salted	49, 600	2, 728	43, 400	3, 348				
Menhaden							21, 000	180
Perch					8, 000	400	10, 000	500
Pollock, fresh	64, 100	854	38, 000	508				
Sea bass					500	40	500	40
Shad					30	4	80	3
Smelt					36, 000	3, 600	36, 000	3, 600
Swordfish, fresh	14, 275	714	43, 450	1, 955				
Miscellaneous fish, fresh	70, 000	870	82, 000	1, 030				
Clams					2, 800	140	3, 000	150
Lobsters	15, 324	868	12, 600	756	127, 500	5, 400	123, 750	5, 500
Total	2, 620, 287	66, 381	2, 080, 699	54, 686	1, 634, 440	33, 079	1, 762, 780	35, 358

Species.	Total.			
	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Alewives	100, 450	$1, 960	146, 750	$3, 080
Cod, fresh	1, 915, 222	36, 911	1, 350, 582	26, 663
Cod, salted	120, 313	3, 007	75, 197	1, 881
Eels	10, 000	1, 000	10, 000	1, 100
Haddock, fresh	997, 746	16, 700	1, 059, 498	18, 800
Haddock, salted	11, 313	226	9, 697	194
Hake, fresh	176, 787	1, 500	209, 992	1, 880
Hake, salted	11, 613	140	9, 700	121
Halibut, fresh	155, 777	11, 756	143, 467	11, 577
Herring, fresh	77, 000	680	208, 000	1, 860
Herring, salted	10, 000	113		
Herring, etc., for bait	136, 000	1, 000	150, 200	1, 200
Mackerel, fresh	144, 377	8, 849	56, 616	4, 118
Mackerel, salted	49, 600	2, 728	43, 400	3, 348
Menhaden			21, 000	180
Perch	8, 000	400	10, 000	500
Pollock, fresh	64, 100	854	38, 000	508
Sea bass	500	40	500	40
Shad	30	4	80	3
Smelt	36, 000	3, 600	36, 000	3, 600
Swordfish, fresh	14, 275	714	43, 450	1, 955
Miscellaneous fish, fresh	70, 000	870	82, 000	1, 030
Clams	2, 800	140	3, 000	150
Lobsters	142, 824	6, 268	136, 350	6, 256
Total	4, 254, 727	99, 460	3, 843, 479	90, 044

35. *Table showing the number of vessels engaged in each fishery in New Hampshire in 1888, together with their tonnage, value, and number of crew.*

Fishery.	No. of vessels engaged.	Net tonnage.	Value of vessels.	Number and nationality of fishermen.			
				Americans.	British provincials.	All others.	Total.
Shore	13	429.49	$24,350	106	9	3	118
Mackerel, New England shore	6	195.32	13,650	46	4	2	52
Halibut	2	90.73	3,600	14	....	7	21
Swordfish	7	191.07	9,700	53	6	2	61
Herring	1	30.93	1,800	7	3	....	10
Lobsters	1	19.41	1,500	6	....	....	6

36. *Table showing by fisheries and species the yield of the vessel fisheries of New Hampshire in* 1888.

Fisheries and species.	Pounds.	Value.	Fisheries and species.	Pounds.	Value.
Shore:			Mackerel, New England shore:		
Cod	892,582	$18,968	Mackerel, caught with seine, fresh	41,716	$2,920
Cod, salted	75,197	1,881	Mackerel, caught with seine, salted	43,400	3,348
Haddock	407,498	8,150	Mackerel, caught with nets, fresh	9,400	658
Haddock, salted	9,697	194	Mackerel, caught with lines, fresh	2,000	140
Hake	209,992	1,880	Total	96,516	7,066
Hake, salted	9,700	121	Lobster	12,600	756
Pollock	38,000	508	Grand total	2,080,699	54,686
Miscellaneous fish	82,000	1,030			
Total	1,724,666	32,732			
Swordfish	43,450	1,955			
Herring	60,000	600			
Halibut	143,467	11,577			

MASSACHUSETTS.

Notwithstanding the marked decadence in the whale fishery and the phenomenal scarcity of mackerel during the two years under consideration, Massachusetts still stands at the head of all the States in the value and importance of its fisheries. Elsewhere the percentage of increase or decrease in the general fisheries of the State has been shown under the head of persons employed, capital invested, value of products, etc. Here it only remains to discuss such phases of these industries as are brought out in greater detail in these tables.

As in the other New England States already considered, there has been a decided falling off in the number of vessels employed, particularly in the whale fishery, where the fleet declined from 161 vessels in 1880 to 74 in 1888. But, although there has been a decrease in the number of vessels engaged in the general fisheries (other than for whales), this has been more than offset by the increase in size and value, there having been an actual increase of more than 5,000 tons in this class of shipping since 1880.

The table showing the catch of mackerel, cod, and halibut by fishing grounds and by condition when landed, is very instructive and suggestive. It throws much light on matters of international consequence, particularly when taken in connection with similar tables for the other

ew England States. It may be explained that the term "Nova Scotia ιore," used here, means that the fish were taken off the coast of that rovince, in the open sea outside of jurisdictional waters. The same ın be said of the Gulf of St. Lawrence and all other fishing grounds, xcept the "New England shore." While American fishing vessels have ıe right to fish inshore over the greater part of the region included under ıe head of "West of 65° W. longitude," it may be stated that this is a ank fishery prosecuted at considerable distances from the coast. It is roper, however, to call attention to the fact that while the mackerel atch off the New England shore in 1888 was 8,322,943 pounds, worth 558,146, the combined catch off the Nova Scotia coast and in the Gulf f St. Lawrence reached an aggregate of only 2,144,200 pounds, with a alue of $178,682.

For this State as well as for others the products of the fisheries are shown in great detail by species and by special fisheries in a manner more complete than has heretofore been attempted, including even the secondary products, such as roe, fish oil, etc.

37. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	11, 182	11, 062
On transporting vessels	28	29
On boats	2, 618	2, 681
On shore, in factories, fish houses, etc	3, 235	3, 265
Total	17, 053	17, 037

28. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing *	830	$3, 118, 006	814	$3, 040, 323
Outfit	....	1, 615, 239	....	1, 539, 536
Vessels transporting †	11	7, 150	11	7, 500
Outfit	....	2, 050	....	2, 100
Boats	3, 310	245, 699	3, 333	251, 070
Apparatus of capture—vessel fisheries:				
Seines	382	191, 000	332	167, 700
Trawl lines, hand lines, etc	....	469, 949	....	494, 478
Gill nets	614	7, 576	628	8, 288
Snap nets	20	60	20	60
Pots	560	980	785	1, 455
Dredges and rakes	30	115	26	100
Apparatus of capture—shore fisheries:				
Haul seines	42	3, 205	46	3, 805
Pound nets, trap nets, and weirs	200	171, 721	218	189, 829
Gill nets	4, 031	46, 103	4, 122	47, 794
Fyke nets	41	630	46	680
Trammel nets	2	35	2	35
Snap nets and dip nets	495	911	500	921
Pots	26, 970	37, 605	28, 532	40, 086
Trawl lines and hand lines	....	2, 092	....	2, 890
Dredges and tongs	1, 082	3, 490	1, 225	3, 810
Harpoons, spears, etc	282	544	297	571
Rakes and hoes	....	5, 146	....	5, 766
Shore property	....	3, 036, 544	....	3, 050, 738
Cash capital	....	4, 239, 200	....	4, 251, 200
Total	....	13, 205, 050	....	13, 110, 765

* Tonnage in 1887, 61,376.48; in 1888, 59,939.83. † Tonnage in 1887, 180.31; in 1888, 189.91.

39. *Table of products.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Albicore	40,000	$125	40,900	$134
Alewives	1,900,339	28,194	2,983,424	39,674
Alewives, salted	1,486,625	36,492	2,205,675	43,856
Bluefish	706,882	61,158	689,904	60,744
Bonito	55,307	1,787	130,605	5,715
Bonito, salted	....	....	1,400	84
Butterfish	503,929	14,198	513,447	14,508
Cod	24,904,116	476,305	23,427,182	516,170
Cod, salted	66,384,295	1,712,703	64,369,603	1,762,061
Cusk	275,554	3,080	344,890	4,676
Cusk, salted	84,070	800	175,596	1,938
Eels	411,904	23,926	424,793	24,346
Flounders	840,710	16,982	853,527	17,691
Grouper	....	....	8,289	212
Haddock	28,932,885	453,408	35,759,801	651,835
Haddock, salted	794,948	10,311	525,571	5,642
Hake	4,489,682	39,684	3,961,725	39,157
Hake, salted	790,492	7,920	923,684	9,711
Halibut	9,034,947	468,554	9,207,065	546,393
Halibut, salted	666,332	41,646	1,336,971	75,671
Herring	7,177,431	60,313	8,224,270	70,838
Herring, salted	1,227,400	13,977	2,097,975	25,938
Hickory shad	6,300	173	3,964	86
Kingfish	3,630	194	6,561	372
Mackerel	5,890,092	287,657	4,755,925	268,800
Mackerel, salted	15,084,500	870,025	8,920,050	659,520
Menhaden	372,740	2,630	3,551,221	12,419
Menhaden, salted	85,200	3,200	708,200	15,058
Perch or cunners	329,946	16,640	316,275	16,184
Pollock	1,707,822	17,495	2,742,640	29,461
Pollock, salted	1,036,877	11,195	1,131,666	12,482
Red snapper	214,735	5,841	153,377	4,772
Scup	2,392,331	72,445	1,785,839	53,456
Sea bass	390,762	22,977	472,573	29,070
Shad	63,319	2,802	179,606	5,312
Shad, salted	69,200	1,948	80,480	2,301
Smelt	11,500	1,233	10,800	1,152
Spanish mackerel	3,988	861	2,199	487
Squeteague	129,671	6,629	170,544	8,972
Striped bass	20,267	2,160	32,024	3,113
Sturgeon	6,400	64	4,500	171
Swordfish	223,050	9,495	264,407	12,549
Swordfish, salted	3,800	171	40,000	1,582
Tautog	744,344	26,576	633,192	24,094
Whiting (*Merlucius*)	45,901	782	69,608	1,222
Miscellaneous fish	22,279	232	22,127	241
Refuse fish	1,010,000	976	1,110,250	992
Clams (*Mya arenaria*)	1,946,380	110,396	2,107,770	117,938
Clams, salted	360,210	10,806	330,000	9,900
Quohaugs (*Venus mercenaria*)	284,320	21,363	209,320	14,822
Oysters	302,281	64,115	319,417	66,453
Scallops	251,783	38,933	157,011	43,202
Lobsters	3,511,075	156,204	3,743,475	172,936
Shrimps	1,000	325	1,250	450
Squid	511,400	5,279	486,200	5,274
Halibut fins	20,000	1,053	70,400	3,402
Sounds	37,206	7,440	38,722	5,808
Tongues	335,512	10,045	315,590	9,469
Roe	....	....	5,000	200
Oil, fish	2,256,130	79,462	1,962,535	72,385
Oil, whale	6,794,180	455,169	4,649,954	328,148
Ambergris	197	22,000	42¼	9,930
Whalebone	222,567	564,901	124,675	338,138
Algæ	102,203,600	80,941	102,150,000	76,178
Total	299,544,343	6,464,396	302,045,686¼	6,355,495

40. *Summary by customs districts of the vessel fisheries of Massachusetts in 1887 and 1888.*

Customs district.	No. of vessels fishing.		Net tonnage.		Value of vessels.		Value of outfit, gear, provisions, fuel, etc.		Number and nationality of fishermen.								Value of catch.	
									1887.				1888.					
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	Americans.	British provincials.	All others.	Total.	Americans.	British provincials.	All others.	Total.	1887.	1888.
Newburyport	6	4	141. 61	115. 40	$6, 750	$6, 200	$11, 437	$7, 800	40	3	......	43	30	1	......	31	$15, 974	$13, 754
Gloucester	417	412	27, 085. 20	26, 465. 17	1, 575, 756	1, 509, 921	1, 107, 560	1, 082, 712	3, 415	1, 203	750	5, 368	3, 387	1, 270	649	5, 306	2, 795, 229	2, 948, 997
Salem and Beverly	18	14	539. 49	469. 61	28, 000	24, 550	19, 710	19, 250	96	21	2	119	68	40	......	108	46, 255	54, 008
Marblehead	27	21	934. 18	736. 89	61, 950	50, 400	55, 842	47, 225	231	9	......	240	192	10	1	203	113, 969	91, 301
Boston	59	61	3, 264. 12	3, 742. 63	205, 250	241, 870	154, 780	173, 210	543	124	76	743	657	106	110	873	383, 973	527, 485
Plymouth	2	1	135. 37	44. 65	7, 000	3, 300	4, 100	2, 000	26	......	......	26	10	......	......	10	3, 120	3, 600
Barnstable	193	193	12, 705. 87	12, 668. 11	571, 770	558. 232	342, 847	325, 327	1, 758	479	251	2, 488	1, 759	465	234	2, 458	982, 265	897, 350
Nantucket	12	13	85. 19	90. 21	6, 175	6, 725	977	667	27	......	......	27	29	......	......	29	3, 854	2, 719
Edgartown	11	18	638. 83	729. 13	25, 400	28, 075	22, 591	23, 151	93	22	16	131	104	22	17	143	2, 745	15, 735
New Bedford	85	77	15, 846. 62	14, 878. 03	629, 955	611, 050	565, 075	530, 275	837	315	845	1, 997	800	286	815	1, 901	1, 030, 369	634, 003
Total	830	814	61, 376. 48	59, 939. 83	3, 118, 006	3, 040, 323	2, 284, 919	2, 211, 617	7, 066	2, 176	1, 940	11, 182	7, 036	2, 200	1, 826	11, 062	5, 377, 753	5, 188, 952

Customs districts.	No. of vessels transporting.		Net tonnage.		Value of vessels.		Value of provisions, fuel, etc.		Number and nationality of crew.								Value of products transported.	
									1887.				1888.					
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	Americans.	British provincials.	All others.	Total.	Americans.	British provincials.	All others.	Total.	1887.	1888.
Newburyport	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Gloucester	1	1	8. 55	8. 55	$550	$500	$100	$100	3	......	......	3	3	......	......	3	$9, 203	$10, 050
Salem and Beverly	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Marblehead	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Boston	1	1	49. 41	49. 41	1, 000	1, 000	300	300	4	......	......	4	4	......	......	4	5, 600	8, 260
Plymouth	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Barnstable	1	1	8. 67	18. 27	200	600	100	150	2	......	......	2	3	......	......	3	2, 500	5, 000
Nantucket	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Edgartown	3	3	43. 64	43. 64	2, 000	2, 000	650	650	9	......	......	9	9	......	......	9	18, 500	20, 000
New Bedford	5	5	70. 04	70. 04	3, 400	3, 400	900	900	10	......	......	10	10	......	......	10	12, 800	12, 140
Total	11	11	180. 31	189. 91	7,150	7, 500	2, 050	2, 100	28	......	......	28	29	......	......	29	48, 603	55, 450

41. *Table showing by species and customs districts the yield of the vessel fisheries of Massachusetts in 1887.*

Species.	Newburyport.		Gloucester.		Salem and Beverly.		Marblehead.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives			48,000	$260				
Cod	683,325	$10,860	9,446,336	165,301	467,320	$8,178	1,982,516	$33,042
Cod, salted			48,798,873	1,208,000	1,580,925	32,158	80,000	2,000
Cusk			54,093	510			35,417	335
Cusk, salted			84,070	800				
Haddock	113,000	1,695	15,091,318	226,370	30,000	470		
Haddock, salted			261,028	2,550	21,000	215	507,670	7,443
Halibut			8,409,805	422,490	3,680	221	22,518	1,126
Halibut, salted			666,332	41,646				
Hake	31,000	265	1,487,291	12,641			69,217	552
Hake, salted			748,930	7,500				
Herring			820,058	5,740	4,000	30	47,500	357
Herring, salted			485,800	6,070	91,000	1,024		
Mackerel	14,000	700	1,904,120	82,521			1,174,300	52,844
Mackerel, salted	44,400	2,338	9,414,200	515,230	17,000	935	100,000	6,000
Menhaden			19,400	485				
Menhaden, salted			80,200	3,070				
Pollock			712,755	7,160			323,860	3,170
Pollock, salted			832,848	8,160	20,000	195	7,000	70
Red snapper			41,750	1,250			172,985	4,591
Scup			16,000	480				
Swordfish			114,030	4,561				
Swordfish, salted			3,800	171				
Lobsters			7,130	214	49,530	1,733	10,000	290
Clams							20,000	1,800
Squid			15,000	37				
Halibut fins			20,000	1,053				
Sounds	539	116	28,555	5,580			1,617	349
Tongues			213,756	6,383	10,252	327		
Oil, fish			1,685,635	58,996	14,137	469		
Algæ					5,400	300		
Total	886,264	15,974	101,511,113	2,795,229	2,314,244	46,255	4,554,600	113,969

Species.	Boston.		Plymouth.		Barnstable.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish					72,679	$5,902
Bonito					125	5
Butterfish					1,500	45
Cod	5,827,097	$116,542			4,542,905	106,190
Cod, salted	608,592	14,590			14,435,696	426,932
Cusk	50,194	485			134,600	1,740
Flounders					15,859	285
Haddock	8,503,761	148,816			4,358,861	66,054
Haddock, salted	250	3			5,000	100
Halibut	302,124	19,638			296,400	25,047
Hake	1,569,574	14,126			664,900	6,899
Hake, salted	41,562	420				
Herring	131,000	910				
Herring, salted	20,000	225				
Mackerel	324,500	16,225	49,900	$2,400	410,522	21,346
Mackerel, salted	754,800	43,731	12,000	720	4,166,600	250,532
Perch or cunners	1,091	109				
Pollock	261,707	2,800			404,000	4,300
Pollock, salted	5,829	60			171,200	2,710
Sea bass					3,235	131
Scup					44,021	938
Shad					10,000	400
Shad, salted					68,000	1,900
Striped bass					1,161	245
Squeteague					3,235	131
Swordfish					2,000	75
Tautog					30,762	922
Lobsters	73,182	2,035				
Sounds	4,330	930			2,165	465
Tongues	2,813	82			106,878	3,191
Oil, fish	10,418	375			545,940	19,622
Oil, whale	21,262	1,871			389,563	26,158
Ambergris					107	10,000
Total	18,514,086	383,973	61,900	3,120	30,887,914	982,265

41. *Table showing by species and customs districts the yield of the vessel fisheries of Massachusetts in* 1887—Continued.

Species.	Nantucket.		Edgartown.		New Bedford.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish	15, 580	$1, 014	7, 882	$668	7, 600	$438
Cod	1, 100	46	2, 000	100	47, 150	1, 534
Cod, salted	15, 000	600			138, 000	4, 175
Haddock	350	7				
Herring					3, 500	70
Mackerel	1, 300	130			60, 750	3, 974
Mackerel, salted	3, 000	300	15, 000	1, 027	84, 400	4, 095
Sea bass			7, 000	590	10, 000	800
Scup					13, 000	480
Swordfish			9, 000	360	77, 050	3, 602
Tautog					58, 000	2, 670
Lobsters					59, 725	3, 423
Scallops	9, 009	1, 757			6, 181	1, 005
Tongues					1, 813	62
Oil, whale					6, 383, 355	427, 140
Ambergris					90	12, 000
Whalebone					222, 567	564, 901
Total	45, 339	3, 854	40, 882	2, 745	7, 173, 181	1, 030, 369

SUMMARY.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Alewives	48, 000	$260	Red snapper	214, 735	$5, 841
Bluefish	103, 741	8, 022	Sea bass	20, 235	1, 521
Bonito	125	5	Scup	73, 021	1, 898
Butterfish	1, 500	45	Shad	10, 000	400
Cod	22, 999, 749	441, 793	Shad, salted	68, 000	1, 900
Cod, salted	65, 657, 086	1, 688, 455	Striped bass	1, 161	215
Cusk	274, 304	3, 070	Squeteague	3, 235	131
Cusk, salted	84, 070	800	Swordfish	202, 080	8, 598
Flounders	15, 859	285	Swordfish, salted	3, 800	171
Haddock	28, 097, 290	443, 412	Tautog	88, 762	3, 592
Haddock, salted	794, 948	10, 311	Lobsters	199, 567	7, 695
Halibut	9, 034, 527	468, 522	Clams	20, 000	1, 800
Halibut, salted	666, 332	41, 646	Scallops	15, 190	2, 762
Hake	3, 821, 982	34, 483	Squid	15, 000	37
Hake, salted	790, 492	7, 920	Halibut fins	20, 000	1, 053
Herring	1, 006, 058	7, 107	Sounds	37, 206	7, 440
Herring, salted	596, 800	7, 319	Tongues	335, 512	10, 045
Mackerel	3, 939, 392	180, 140	Oil, fish	2, 256, 130	79, 462
Mackerel, salted	14, 611, 400	824, 908	Oil, whale	6, 794, 180	455, 169
Menhaden	19, 400	485	Ambergris	197	22, 000
Menhaden, salted	80, 200	3, 070	Whalebone	222, 567	564, 901
Perch or cunners	1, 091	109	Algæ	5, 400	300
Pollock	1, 702, 322	17, 430			
Pollock, salted	1, 036, 877	11, 195	Total	165, 989, 523	5, 377, 753

42. *Table showing by species and customs districts the yield of the vessel fisheries of Massachusetts in* 1888.

Species.	Newburyport.		Gloucester.		Salem and Beverly.		Marblehead.	
	Pounds.	Value	Pounds	Value.	Pounds.	Value.	Pounds.	Value.
Alewives			4, 500	$18				
Alewives, salted			3, 400	47				
Butterfish			8, 333	245				
Cod	489, 825	$9, 189	8, 877, 701	200, 599	529, 965	$10, 540	1, 309, 799	$23, 631
Cod, salted	10, 000	250	48, 373, 794	1, 285, 659	1, 432, 916	37, 616		
Cusk			87, 740	1, 069				
Cusk, salted			175, 596	1, 938				
Haddock	105, 000	1, 680	17, 745, 664	323, 809	110, 273	1, 654	599, 863	7, 998
Haddock, salted	16, 250	160	409, 591	4, 416	65, 000	630		
Halibut			8, 380, 671	474, 788	514	31	97, 583	4, 869
Halibut, salted			1, 328, 236	75, 300	7, 500	306		
Hake			1, 202, 575	11, 879	5, 000	38		
Hake, salted			923, 684	9, 711				
Herring			181, 750	1, 737	1, 000	6		
Herring, salted			1, 522, 600	19, 301	40, 000	400	50, 000	565
Mackerel	5, 000	359	209, 320	13, 237	5, 000	300	782, 666	41, 090

42. *Table showing by species and customs districts the yield of the vessel fisheries of Massachusetts in* 1888—Continued.

Species.	Newburyport.		Gloucester.		Salem and Beverly.		Marblehead.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mackerel, salted	28,600	$2,125	5,310,200	$105,177			78,000	$5,460
Menhaden			119,200	883				
Menhaden, salted			680,600	14,375				
Pollock			1,854,683	20,168			235,757	2,125
Pollock, salted			879,627	8,752	11,139	$105		
Red snapper							92,500	3,250
Scup			8,750	265				
Shad, salted			17,800	547				
Swordfish			151,896	7,174				
Swordfish, salted			37,400	1,482				
Lobsters			6,600	264	31,470	1,101	22,666	793
Clams					750	30	19,000	1,520
Squid			18,000	150				
Halibut fins			70,400	3,402				
Sounds			23,326	3,483				
Tongues			198,354	5,950	9,723	295		
Roe			5,000	200				
Oil, fish			1,471,450	52,972	28,680	956		
Total	654,675	13,754	100,288,441	2,948,997	2,278,930	54,008	3,287,834	91,301

Species.	Boston.		Plymouth.		Barnstable.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish					56,294	$5,582
Bonito					315	11
Butterfish					1,260	38
Cod	4,726,510	$94,938	70,000	$1,400	5,487,070	140,234
Cod, salted	1,847,230	49,515			11,827,484	360,251
Cusk	11,000	148			244,900	3,449
Flounders					7,833	165
Grouper					8,289	212
Haddock	11,089,400	220,775	90,000	1,600	5,182,149	84,231
Haddock, salted	33,380	399			1,350	37
Halibut	355,000	35,485			372,802	31,183
Halibut, salted	235	15			1,000	50
Hake	1,128,300	12,100			961,800	9,968
Herring	65,000	613				
Herring, salted	32,000	480			1,000	50
Kingfish					833	25
Mackerel	678,575	40,783	10,000	600	248,382	14,951
Mackerel, salted	758,000	50,556			2,233,760	154,058
Menhaden	2,500,000	6,250			116,000	600
Menhaden, salted	17,600	440				
Perch or cunners	8,400	624				
Pollock	87,000	1,380			554,200	5,658
Pollock, salted					240,900	3,625
Red snapper					60,877	1,522
Sea bass					2,335	140
Scup					8,231	226
Shad					95,000	2,145
Shad, salted	2,000	50			58,000	1,600
Striped bass					245	20
Squeteague					3,151	124
Swordfish	5,500	275			23,800	665
Swordfish, salted					2,600	100
Tautog					10,808	320
Lobsters	152,818	5,853				
Sounds	9,234	1,395			6,162	930
Tongues	3,295	98			102,647	3,079
Oil, fish	17,737	665			444,668	17,792
Oil, whale	25,987	2,148			638,130	47,179
Ambergris					9¾	2,730
Whalebone					2,900	4,400
Algæ	45,000	2,500				
Total	23,599,201	527,485	170,000	3,600	29,007,184¾	897,350

42. *Table showing by species and customs districts the yield of the vessel fisheries of Massachusetts in* 1888—Continued.

Species.	Nantucket.		Edgartown.		New Bedford.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish	14, 400	$643	27, 120	$2, 131	1, 600	$128
Cod	....	....	10, 554	334	15, 500	640
Cod, salted	16, 050	642	....	....	145, 000	4, 250
Flounders	....	....	1, 694	70	....	....
Haddock	1, 000	30	3, 577	79	....	....
Mackerel	550	45	11, 350	601	13, 100	761
Mackerel, salted	....	....	23, 240	1, 554	71, 400	5, 270
Menhaden	....	....	20, 000	91	54, 000	135
Sea bass	....	....	30, 600	2, 247	2, 000	160
Scup	600	14	....	....	54, 230	1, 837
Swordfish	....	....	14, 446	557	45, 345	2, 857
Tautog	....	....	....	....	41, 428	1, 824
Lobsters	....	....	....	....	57, 000	2, 835
Scallops	7, 245	1, 345	7, 753	1, 371	931	200
Tongues	....	....	....	....	1, 571	47
Oil, whale	....	....	82, 687	6, 700	3, 903, 150	272, 121
Ambergris	....	....	....	....	32½	7, 200
Whalebone	....	....	....	....	121, 775	333, 738
Total	39, 845	2, 719	233, 021	15, 735	4, 528, 062½	634, 003

SUMMARY.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Alewives	4, 500	$18	Pollock, salted	1, 131, 666	$12, 482
Alewives, salted	3, 400	47	Red snapper	153, 377	4, 772
Bluefish	99, 414	8, 484	Sea bass	34, 935	2, 547
Bonito	315	11	Scup	71, 811	2, 342
Butterfish	9, 593	283	Shad	95, 000	2, 145
Cod	21, 516, 924	481, 505	Shad, salted	77, 800	2, 197
Cod, salted	63, 652, 474	1, 738, 183	Striped bass	245	20
Cusk	343, 640	4, 666	Squeteague	3, 151	124
Cusk, salted	175, 596	1, 938	Swordfish	240, 987	11, 528
Flounders	9, 527	235	Swordfish, salted	40. 000	1, 582
Grouper	8, 289	212	Tautog	52, 236	2, 144
Haddock	34, 926, 926	641, 856	Lobsters	270, 554	10, 846
Haddock, salted	525, 571	5, 642	Clams	19, 750	1, 550
Halibut	9, 206, 570	546, 356	Scallops	15, 929	2, 916
Halibut, salted	1, 336, 971	75, 671	Squid	18, 000	150
Hake	3, 297, 675	33, 985	Halibut fins	70, 400	3, 402
Hake, salted	923, 684	9, 711	Sounds	38, 722	5, 808
Herring	247, 750	2, 356	Tongues	315, 590	9, 469
Herring, salted	1, 645, 600	20, 796	Roe	5, 000	200
Kingfish	833	25	Oil, fish	1, 962, 535	72, 385
Mackerel	1, 963, 943	112, 718	Oil, whale	4, 649, 954	328, 148
Mackerel, salted	8, 503, 200	624, 200	Ambergris	42¼	9, 930
Menhaden	2, 809, 200	7, 959	Whalebone	124, 675	338, 138
Menhaden, salted	698, 200	14, 815	Algæ	45, 000	2, 500
Perch or cunners	8, 400	621			
Pollock	2, 731, 640	29, 331	Total	164, 087, 194½	5, 188, 952

43. *Table showing by fisheries and species the yield of the vessel fisheries of Massachusetts in* 1888.

Fisheries and species.	Pounds.	Value.
Bank:		
Cod	157, 629	$3, 585
Cod, salted	62, 450, 150	1, 709, 167
Cusk, salted	157, 496	1, 627
Haddock, salted	402, 061	4, 314
Halibut	1, 033, 078	70, 388
Halibut, salted	245, 353	13, 060
Hake	20, 334	200
Hake, salted	710, 457	7, 352
Pollock	1, 700	20
Pollock, salted	768, 185	7, 625
Halibut fins	2, 800	135
Total	65, 949, 243	1, 817, 473
Market:		
Cod	14, 496, 816	338, 961
Cod, salted	139, 642	4, 072
Cusk	302, 900	4, 109
Cusk, salted	600	9
Grouper	8, 289	212
Haddock	31, 989, 775	592, 203
Halibut	770, 240	69, 297
Hake	2, 696, 083	28, 169
Hake, salted	4, 850	45
Pollock	1, 301, 848	13, 628
Red snapper	153, 377	4, 772
Swordfish	2, 309	127
Total	51, 866, 729	1, 055, 604
Halibut:		
Cod	5, 546	149
Cod, salted	149, 960	3, 543
Halibut	7, 267, 929	399, 250
Halibut, salted	1, 091, 493	62, 603
Hake, salted	5, 685	60
Halibut fins	67, 600	3, 267
Total	8, 588, 213	468, 872
Shore:		
Bluefish	99, 414	8, 484
Bonito	315	11
Butterfish	9, 593	283
Cod	6, 856, 933	138, 810
Cod, salted	912, 722	21, 401
Cusk	40, 740	557
Cusk, salted	17, 500	302
Flounders	9, 527	235
Haddock	2, 937, 151	49, 653
Haddock, salted	123, 510	1, 328
Halibut	135, 323	7, 421
Halibut, salted	125	8
Hake	581, 258	5, 616
Hake, salted	202, 692	2, 254
Kingfish (*Scomberomorus*)	833	25
Shore—continued:		
Mackerel	550	$45
Menhaden	20, 000	91
Perch or cunners	8, 400	624
Pollock	1, 428, 092	15, 683
Pollock, salted	363, 481	4, 857
Sea bass	34, 935	2, 547
Scup	71, 811	2, 342
Shad	95, 000	2, 145
Shad, salted	58, 000	1, 600
Striped bass	245	20
Squeteague	3, 151	124
Swordfish	25, 496	1, 155
Tautog	52, 236	2, 144
Algæ	45, 000	2, 500
Total	14, 134, 033	272, 265
Mackerel:		
Herring	93, 750	913
Herring, salted	50, 600	732
Mackerel	1, 963, 393	112, 673
Mackerel, salted	8, 503, 200	624, 200
Menhaden, salted	698, 200	14, 815
Shad, salted	2, 000	50
Swordfish, salted	40, 000	1, 582
Roe	5, 000	200
Total	11, 356, 143	755, 165
Menhaden (salted)	2, 789, 200	7, 868
Swordfish	213, 182	10, 246
Herring:		
Alewives	4, 500	18
Alewives, salted	3, 400	47
Herring	154, 000	1, 443
Herring, salted	1, 595, 000	20, 064
Shad, salted	17, 800	547
Squid	18, 000	150
Total	1, 792, 700	22, 269
Mollusk:		
Clams	19, 750	1, 556
Scallops	15, 929	2, 910
Total	35, 679	4, 466
Lobster	270, 554	10, 846
Whale:		
Whale oil	4, 649, 954	328, 148
Whalebone	124, 675	338, 138
Ambergris	42¼	9, 930
Total	4, 774, 671¼	676, 216

NOTE.—This table does not include 1,962,535 pounds of fish oil, valued at $72,385; 38,722 pounds of sounds, valued at $5,808; and 315,590 pounds of tongues, valued at $9, 469.

44. *Table showing the number of vessels engaged in each fishery in Massachusetts in 1888, together with their tonnage, value, and number of crew.*

Fishery.	No. of vessels engaged.	Net tonnage.	Value of vessels.	Number and nationality of fishermen.			
				Americans.	British provincials.	All others.	Total.
Cod, on banks east of 65° W. longitude	196	16,848.20	$882,329	1,714	986	306	3,006
Cod, on banks west of 65° W. longitude	163	10,405.75	535,100	1,320	524	224	2,068
Cod, Gulf of St. Lawrence	2	122.05	3,080	14	11	......	25
Halibut, on banks east of 65° W. longitude*	42	3,564.21	235,980	330	170	107	607
Halibut, Greenland and Iceland	6	518.27	29,100	60	11	19	90
Mackerel, New England shore	312	14,212.15	755,724	2,573	497	203	3,273
Mackerel, Nova Scotia shore	28	2,438.67	150,060	350	108	25	483
Mackerel, Gulf of St. Lawrence	53	4,512.24	293,359	619	206	75	900
Whale	75	16,072.26	655,670	933	323	841	2,097
Market	161	10,710.39	640,285	1,588	428	306	2,322
Shore	137	2,876.16	169,588	732	80	48	860
Herring	27	413.61	19,550	119	12	1	132
Swordfish	12	324.21	18,000	84	10	14	108
Menhaden	8	458.61	31,450	95	16	3	114
Lobster	10	135.97	6,950	34	2	3	39
Scallop and clam	8	138.23	5,950	23	4	......	27

* The vessels landing fresh cod, haddock, halibut, etc., caught on George's Bank and New England shore are included in the market and shore fisheries.

45. *Table showing by fishing grounds the catch of the mackerel (by apparatus), the bank cod, the Grand and Western Bank fresh halibut, and the Greenland and Iceland halibut fleets of Massachusetts in* 1888.

Species.	New England shore.		Nova Scotia shore.		Gulf St. Lawrence.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mackerel caught with seines, fresh	1,583,430	$90,006	80,000	$4,800	....	......
Mackerel caught with seines, salted	5,847,160	410,200	849,200	61,670	1,215,000	$112,212
Mackerel caught with nets, fresh	104,920	6,639	....	....	....	....
Mackerel caught with nets, salted	192,000	12,657	....	....	....	....
Mackerel caught with lines, fresh	195,593	11,273	....	....	....	....
Mackerel caught with lines, salted	399,840	27,371	....	....	....	....
Cod, salted	....	....	....	....	226,240	8,785
Total	8,322,943	558,146	929,200	66,470	1,441,240	120,997

Species.	East of 65° West longitude.		West of 65° West longitude.		Greenland and Iceland.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Cod, salted	38,562,725	$1,074,070	23,661,185	$626,312	2,700	$75
Halibut, fresh	7,301,432	401,154	....	....	....	....
Halibut, salted	181,856	9,509	....	....	1,017,643	60,247
Total	46,046,013	1,484,733	23,661,185	626,312	1,020,343	60,322

Species.	Total.	
	Pounds.	Value.
Mackerel caught with seines, fresh	1,663,430	$94,806
Mackerel caught with seines, salted	7,911,360	584,082
Mackerel caught with nets, fresh	104,920	6,639
Mackerel caught with nets, salted	192,000	12,657
Mackerel caught with lines, fresh	195,593	11,273
Mackerel caught with lines, salted	399,840	27,371
Cod, salted	62,452,850	1,709,242
Halibut, fresh	7,301,432	401,154
Halibut, salted	1,199,499	69,756
Total	81,420,924	2,916,980

46. *Table showing by species and condition in which sold the yield of the shore fisheries of Massachusetts in* 1887 *and* 1888.

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Fresh:				
Albicore or horse mackerel	40,000	$125	40,900	$134
Alewives	1,852,339	27,934	2,978,924	39,656
Bluefish	603,141	53,136	590,490	52,260
Bonito	55,182	1,782	130,290	5,704
Butterfish	502,429	14,153	503,854	14,225
Cod	1,904,367	34,512	1,910,258	34,665
Cusk	1,250	10	1,250	10
Eels	411,904	23,926	424,793	24,346
Flounders	824,851	16,697	844,000	17,456
Haddock	835,595	9,996	832,875	9,979
Hake	667,700	5,201	664,050	5,172
Halibut	420	32	495	37
Herring	6,171,373	53,206	7,976,520	68,482
Hickory shad	6,300	173	3,964	86
Kingfish	3,630	194	5,728	347
Mackerel	1,950,700	107,517	2,791,982	156,082
Menhaden	353,340	2,145	742,021	4,460
Perch or cunners	328,855	16,531	307,875	15,560
Pollock	5,500	65	11,000	130
Scup	2,249,310	70,547	1,714,028	51,114
Sea bass	370,527	21,456	437,638	26,523
Shad	53,319	2,402	84,606	3,167
Spanish mackerel	3,988	861	2,199	487
Smelt	11,500	1,233	10,800	1,152
Squeteague	126,436	6,498	167,393	8,848
Striped bass	19,106	1,915	31,779	3,093
Sturgeon	6,400	64	4,500	171
Swordfish	20,970	897	23,420	1,021
Tautog	655,582	22,984	580,956	21,950
Whiting (*Merlucius*)	45,901	782	69,608	1,222
Miscellaneous fish	22,279	232	22,127	241
Refuse fish	1,010,000	976	1,110,250	992
Squid	496,400	5,242	468,200	5,124
Lobsters	3,311,508	148,509	3,472,921	162,090
Shrimp	1,000	325	1,250	450
Oysters	302,281	64,115	319,416	66,453
Scallops	236,593	36,171	141,082	40,286
Clams	1,926,380	108,596	2,088,020	116,388
Quohaugs	284,320	21,363	209,320	14,822
Algæ	102,198,200	80,641	102,105,000	73,678
Total	129,870,876	963,144	133,825,782	1,048,063
Salted:				
Alewives	1,486,625	36,492	2,202,275	43,809
Bonito	....	....	1,400	84
Cod	727,209	24,248	717,129	23,878
Herring	630,600	6,658	452,375	5,142
Mackerel	473,100	45,117	416,850	35,320
Menhaden	5,000	130	10,000	243
Shad	1,200	48	2,680	104
Clams	360,210	10,806	330,000	9,900
Total	3,683,944	123,499	4,132,709	118,480
Total fresh and salted:				
Albicore or horse mackerel	40,000	125	40,900	134
Alewives	3,338,964	64,426	5,181,199	83,465
Bluefish	603,141	53,136	590,490	52,260
Bonito	55,182	1,782	131,690	5,788
Butterfish	502,429	14,153	503,854	14,225
Cod	2,631,576	58,760	2,627,387	58,543
Cusk	1,250	10	1,250	10
Eels	411,904	23,926	424,793	24,346
Flounders	824,851	16,697	844,000	17,456
Haddock	835,595	9,996	832,875	9,979
Hake	667,700	5,201	664,050	5,172
Halibut	420	32	495	37
Herring	6,801,973	59,864	8,428,895	73,624
Hickory shad	6,300	173	3,964	86
Kingfish	3,630	194	5,728	347
Mackerel	2,423,800	152,634	3,208,832	191,402
Menhaden	358,340	2,275	752,021	4,703
Perch or cunners	328,855	16,531	307,875	15,560
Pollock	5,500	65	11,000	130
Scup	2,249,310	70,547	1,714,028	51,114
Sea bass	370,527	21,456	437,638	26,523

46. *Table showing by species and condition in which sold the yield of the shore fisheries of Massachusetts in* 1887 *and* 1888—Continued.

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Total fresh and salted—Continued.				
Shad	54, 519	$2, 450	87, 286	$3, 271
Spanish mackerel	3, 988	861	2, 199	487
Smelt	11, 500	1, 233	10, 800	1, 152
Squeteague	126, 436	6, 498	167, 393	8, 848
Striped bass	19, 106	1, 915	31, 779	3, 093
Sturgeon	6, 400	64	4, 500	171
Swordfish	20, 970	897	23, 420	1, 021
Tautog	655, 582	22, 984	580, 956	21, 950
Whiting (*Merlucius*)	45, 901	782	69, 608	1, 222
Miscellaneous fish	22, 279	232	22, 127	241
Refuse fish	1, 010, 000	976	1, 110, 250	992
Squid	496, 400	5, 242	468, 200	5, 124
Lobsters	3, 311, 508	148, 509	3, 472, 921	162, 090
Shrimp	1, 000	325	1, 250	450
Oysters	302, 281	64, 115	319, 416	66, 453
Scallops	236, 593	36, 171	141, 082	40, 286
Clams	2, 286, 590	119, 402	2, 418, 020	126, 288
Quohaugs	284, 320	21, 363	209, 320	14, 822
Algæ	102, 198, 200	80, 641	102, 105, 000	73, 678
Total	133, 554, 820	1, 086, 643	137, 958, 491	1, 166, 543

47. *Table showing by species the yield of the pound-net fishery of Massachusetts.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Albicore or horse mackerel	40, 000	$125	40, 900	$134
Alewives	944, 550	11, 711	887, 764	11, 041
Alewives, salted	62, 700	803	80, 000	1, 000
Bluefish	104, 632	7, 683	104, 212	6, 660
Bonito	49, 547	1, 504	119, 505	5, 319
Bonito, salted			1, 400	84
Butterfish	433, 314	12, 005	421, 172	11, 655
Cod	12, 220	327	29, 313	669
Eels	19, 105	895	48, 647	2, 334
Flounders	664, 654	13, 010	692, 602	13, 918
Herring	3, 192, 978	28, 371	5, 181, 870	48, 371
Herring, salted	110, 000	1, 275	114, 600	1, 339
Hickory shad	6, 300	173	3, 964	86
Kingfish	2, 155	121	2, 533	175
Mackerel	1, 240, 166	64, 873	1, 763, 881	104, 518
Mackerel, salted	245, 400	25, 996	196, 800	16, 156
Menhaden	233, 840	1, 107	577, 885	3, 048
Menhaden slivers			5, 000	118
Scup	1, 703, 092	52, 114	1, 076, 876	32, 067
Sea bass	162, 085	11, 087	227, 389	16, 255
Shad	46, 137	2, 129	69, 724	2, 887
Shad, salted	1, 200	48	2, 680	104
Spanish mackerel	3, 888	843	1, 945	423
Smelt	2, 500	205	2, 800	255
Squeteague	102, 683	5, 388	141, 499	7, 689
Striped bass	14, 099	1, 315	14, 551	1, 262
Sturgeon	800	32	2, 675	107
Tautog	183, 974	4, 839	134, 647	4, 645
Whiting (*Merlucius*)	45, 751	780	69, 600	1, 214
Miscellaneous fish	1, 504	82	1, 342	89
Refuse fish	760, 000	776	810, 250	792
Squid	491, 600	5, 168	463, 400	5, 050
Total	10, 880, 874	254, 785	13, 291, 426	299, 464

RHODE ISLAND.

The tables presented show many phases of the fisheries not similarly exhibited in the statistics of 1880; it is difficult therefore to institute comparisons in all cases. There has been a large decrease in persons employed, amounting to 26 per cent., and an increase of 73 per cent. in capital invested and 18 per cent. in the catch. This is due to the improvement in the vessels, especially those employed in menhaden fishing, in the menhaden factories, and in the pound-net and trap fisheries. There is not much difference in the value of menhaden vessels; in the aggregate fewer vessels are now employed, but these are of an improved type, and, with fewer men, perform the same work that was done by a larger fleet in 1880.

There has been a gratifying increase in the menhaden industry, the manufactured products of which in 1880 were valued at $221,748, while in 1888 the amount was $334,686. This is the most important fishery of the State, taking the value of the manufactured products as a basis, but is excelled by the oyster industry, if we consider only the amount paid to fishermen for their catch. With the exception of the menhaden industry, there is no important vessel fishery; the craft employed are generally small and engaged in shore or market fishing.

48. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	364	400
On transporting vessels	14	17
On boats	915	875
On shore, in factories, etc	342	411
Total	1, 635	1, 703

49. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing *	55	$171, 400	64	$194, 150
Outfit		23, 281		29, 085
Vessels transporting †	7	2, 550	9	3, 225
Outfit		530		510
Boats	743	91, 324	749	91, 679
Apparatus of capture—vessel fisheries:				
Purse seines	17	10, 950	17	10, 800
Hand lines and trawl lines		1, 750		1, 555
Gill nets	3	30	9	90
Harpoons	20	300	32	480
Pots	175	350	225	450
Dredges, rakes, etc	72	919	75	975
Apparatus of capture—shore fisheries:				
Haul seines	42	2, 900	42	2, 900
Hand lines and trawl lines		180		179
Trap nets and pound nets	160	72, 400	166	79, 870
Fyke nets	354	2, 570	374	2, 670
Gill nets	99	6, 270	96	6, 090
Dredges, tongs, etc	999	7, 483	493	2, 950
Pots	5, 600	6, 798	5, 450	6, 723
Miscellaneous apparatus		12		10
Shore property		348, 264		353, 485
Cash capital		242, 500		235, 000
Total		992, 761		1, 022, 876

* Tonnage in 1887, 1,221.21; in 1888, 1,349.60. † Tonnage in 1887, 105.30; in 1888, 131.91.

50. *Table of products.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Alewives	682, 800	$10, 250	666, 800	$10, 215
Alewives, salted	325, 000	6, 500	415, 000	8, 500
Alewives, smoked	130, 000	2, 250	150, 000	2, 450
Bluefish	321, 650	22, 305	388, 850	23, 140
Butterfish	266, 000	9, 320	283, 000	9, 810
Cod	204, 394	6, 499	253, 250	7, 653
Cod, salted	82, 558	3, 754	53, 140	2, 009
Eels	318, 000	16, 950	321, 600	17, 332
Flounders	426, 300	11, 406	558, 000	13, 290
Haddock	87, 450	2, 468	86, 460	2, 607
Haddock, salted	4, 464	147	4, 704	118
Kingfish	8, 000	3[illegible]0	8, 500	298
Mackerel	268, 063	18, 545	237, 100	20, 007
Mackerel, salted	500, 200	28, 541	303, 800	23, 624
Menhaden	34, 035, 000	85, 088	78, 269, 800	195, 277
Perch	61, 000	2, 440	60, 000	2, 400
Pollock, salted	50, 960	1, 752	50, 400	1, 800
Scup	3, 030, 033	75, 545	4, 207, 700	84, 480
Sea bass	497, 800	13, 090	512, 400	15, 504
Shad	16, 700	1, 247	17, 400	1, 213
Smelts	55, 000	2, 875	61, 500	3, 135
Squeteague	268, 000	10, 450	275, 000	11, 540
Striped bass	61, 200	5, 324	85, 500	7, 048
Swordfish	101, 452	4, 430	217, 063	9, 718
Tautog	182, 000	7, 200	187, 450	7, 608
Miscellaneous fish	83, 545	1, 289	122, 361	1, 677
Refuse fish	860, 000	1, 090	1, 396, 000	1, 756
Lobsters	570, 039	27, 128	588, 500	28, 047
Crabs	4, 800	1, 200	4, 000	1, 000
Oysters	1, 358, 210	261, 026	1, 324, 785	252, 601
Clams (*Mya arenaria*)	258, 250	25, 030	308, 250	30, 030
Quohaugs (*Venus mercenaria*)	153, 720	15, 699	264, 232	28, 075
Scallops	11, 284	2, 337	4, 942	1, 130
Total	45, 284, 872	683, 495	91, 687, 487	825, 092

51. *Summary by customs districts of the vessel fisheries of Rhode Island in* 1887 *and* 1888.

Designation.	Newport.		Bristol and Warren.		Providence.		Total.	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
Number and nationality of fishermen:								
Americans	300	330	10	14	48	56	358	400
All others	....	....	....	....	6	....	6	....
Total	300	330	10	14	54	56	364	400
Number and nationality of crews on transports:								
Americans	14	17	....	....	....	....	14	17
Number of vessels fishing	35	40	5	6	15	18	55	64
Number of vessels transporting	7	9	....	....	....	....	7	9
Net tonnage of vessels fishing	1, 045. 71	1, 089. 63	43. 25	48. 52	132. 25	211. 45	1, 221. 21	1, 349. 60
Net tonnage of vessels transporting	105. 30	131. 91	....	....	....	....	105. 30	131. 91
Value of vessels fishing	$155, 100	$166, 350	$2, 900	$5, 200	$13, 400	$22, 600	$171, 400	$194, 150
Value of vessels transporting	2, 550	3, 225	....	....	....	....	2, 550	3, 225
Value of outfit, gear, provisions, fuel, etc., of vessels fishing	34, 555	37, 785	475	1, 225	2, 550	4, 425	37, 580	43, 435
Value of provisions, fuel, etc., of vessels transporting	530	510	....	....	....	....	530	510
Value of catch of vessels fishing	128, 407	239, 922	3, 060	7, 870	42, 656	45, 271	174, 123	293, 063
Value of products transported	12, 400	13, 840	....	....	....	....	12, 400	13, 840

52. *Table showing by apparatus and species the yield of the vessel fisheries of Rhode Island in 1887 and 1888.*

Apparatus and species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Hand lines and trawl lines:				
Bluefish	12, 150	$709	42, 200	$1, 962
Cod	133, 894	4, 329	180, 250	5, 408
Cod, salted	66, 878	3, 054	38, 580	1, 359
Haddock	80, 950	2, 313	80, 460	2, 462
Haddock, salted	4, 464	147	4, 704	118
Mackerel	43, 063	3, 545	29, 300	2, 637
Mackerel, salted	324, 200	17, 981	167, 800	13, 424
Tautog			3, 950	158
Total	665, 599	32, 078	547, 244	27, 528
Seines:				
Mackerel			4, 000	360
Menhaden	34, 035, 000	85, 088	78, 269, 800	195, 277
Miscellaneous fish	7, 045	141	4, 361	97
Total	34, 042, 045	85, 229	78, 278, 161	195, 734
Gill nets:				
Bluefish			650	30
Mackerel			4, 000	360
Scup	2, 833	85	1, 700	50
Total	2, 833	85	6, 350	440
Harpoons:				
Swordfish	101, 452	4, 430	217, 063	9, 718
Pots:				
Eels			4, 100	246
Lobsters	20, 039	1, 128	38, 500	2, 047
Total	20, 039	1, 128	42, 600	2, 293
Dredges and rakes:				
Oysters	239, 710	45, 887	281, 288	53, 645
Quohaugs	33, 720	2, 949	24, 238	2, 575
Scallops	11, 284	2, 337	4, 942	1, 130
Total	284, 714	51, 173	310, 468	57, 350
Grand total	35, 116, 682	174, 123	79, 401, 886	293, 063

53. *Table showing by fisheries and species the yield of vessel fisheries of Rhode Island in 1888.*

Fisheries and species.	Pounds.	Value.	Fisheries and species.	Pounds.	Value.
Shore:			Mackerel:		
Bluefish	42, 850	$1, 992	Mackerel	37, 300	$3, 357
Cod	180, 250	5, 408	Mackerel, salted	167, 800	13, 424
Cod, salted	38, 580	1, 359	Miscellaneous fish	4, 361	97
Eels	4, 100	246			
Haddock	80, 460	2, 462	Total	209, 461	16, 878
Haddock, salted	4, 704	118			
Scup	1, 700	50	Mollusk:		
Tautog	3, 950	158	Oysters	281, 288	53, 645
			Quohaugs	24, 238	2, 575
Total	356, 594	11, 793	Scallops	4, 942	1, 130
Swordfish	217, 063	9, 718	Total	310, 468	57, 350
Menhaden	78, 269, 800	195, 277			
Lobster	38, 500	2, 047	Grand total	79, 401, 886	293, 063

54. *Table showing the number of vessels engaged in each fishery in Rhode Island in* 1888, *together with their tonnage, value, and number of crew.*

Fishery.	Number of vessels engaged.	Net tonnage.	Value of vessels.	Number of fishermen.*
Mackerel	30	375.95	$35,500	119
Menhaden	12	770.00	136,000	225
Shore	21	243.91	20,800	80
Swordfish	16	210.89	25,250	60
Crustacean	3	17.55	1,600	9
Mollusk	22	191.36	24,300	53

*All American citizens.

55. *Table showing by apparatus and species the yield of the shore fisheries of Rhode Island in* 1887 *and* 1888, *exclusive of the shellfish and crustacean fisheries.*

Apparatus.	Species.	1887.		1888.	
		Pounds.	Value.	Pounds.	Value.
Pound nets	Alewives	681,800	$10,230	664,300	$10,170
	Alewives, salted	10,000	200	15,600	325
	Alewives, smoked	80,000	1,250	95,000	1,552
	Bluefish	53,500	3,076	65,800	3,948
	Butterfish	262,000	9,240	277,700	9,704
	Eels	75,000	3,000	111,000	5,994
	Flounders	313,300	8,566	408,000	9,545
	Kingfish	8,000	320	8,500	298
	Scup	3,027,200	75,460	4,206,000	84,430
	Sea bass	485,300	12,640	496,300	14,976
	Shad	7,500	562	8,400	588
	Smelt	40,000	2,000	42,200	2,153
	Squeteague	252,000	9,660	255,850	10,692
	Striped bass	50,000	4,250	73,000	6,032
	Tautog	25,000	950	52,000	2,070
	Miscellaneous fish *	76,500	1,148	118,000	1,580
	Refuse fish †	860,000	1,090	1,396,000	1,756
	Total	6,307,100	143,642	8,293,650	165,813
Gill nets	Bluefish	218,500	16,170	230,700	13,842
	Buttertish	1,000	20	1,800	36
	Squeteague	9,000	410	10,650	373
	Total	228,500	16,600	243,150	14,251
Fyke nets	Flounders	93,000	2,410	125,800	3,145
Pots	Eels	198,000	12,250	161,000	8,635
Haul seines	Alewives	1,000	20	2,500	45
	Alewives, salted	315,000	6,300	399,400	8,175
	Alewives, smoked	50,000	1,000	55,000	898
	Bluefish	2,500	250	4,000	400
	Butterfish	3,000	60	3,500	70
	Eels	45,000	1,700	45,500	2,457
	Flounders	6,000	120	8,000	200
	Perch or cunners	61,000	2,440	60,000	2,400
	Sea bass	500	20	600	24
	Shad	9,200	685	9,000	625
	Smelt	15,000	875	19,300	982
	Squeteague	7,000	380	8,500	475
	Striped bass	11,200	1,074	12,500	1,016
	Tautog	5,000	250	6,250	312
	Total	531,400	15,174	634,050	18,079
Lines	Bluefish	35,000	2,100	45,500	2,958
	Cod	70,500	2,170	73,000	2,245
	Cod, salted	15,680	700	14,560	650
	Flounders	14,000	310	16,200	400
	Haddock	6,500	155	6,000	145
	Mackerel	225,000	15,000	199,800	16,650
	Mackerel, salted	176,000	10,560	136,000	10,200
	Pollock	50,960	1,752	50,400	1,800
	Sea bass	12,000	430	15,500	504
	Tautog	152,000	6,000	125,250	5,068
	Total	757,640	39,177	682,210	40,620
	Grand total	8,115,640	229,25	10,139,860	250,543

* Miscellaneous fish includes the cheaper grades of food-fishes, as flatfish, flounders, scup, squeteague, etc., which have been taken in small quantities and shipped without regard to quantities of different species; also, species of infrequent occurrence not sufficiently important to separate.

† Principally sculpin and menhaden used in the production of oil and fertilizer, and a few other species unfit for market because of their small size or deterioration in quality.

56. *Table showing the extent of the menhaden industry of Rhode Island.*

Designation.	1887.	1888.
Number of factories in operation	3	3
Value of factories	$193,000	$193,000
Amount of cash capital	$69,000	$70,000
Number of shoresmen employed	177	246
Number of fishermen employed	222	225
Number of steam vessels employed	11	11
Net tonnage	766.88	747.56
Value	$126,000	$135,000
Value of outfit	$30,000	$29,000
Number of sailing vessels employed in fishing	1	1
Net tonnage	27.50	22.44
Value	$1,500	$1,000
Value of outfit	$1,000	$700
Number of sailing vessels employed as "carryaways"	3	5
Net tonnage	42.32	64.08
Value	$1,400	$1,825
Value of outfit	$180	$265
Number of menhaden handled	60,901,670	127,169,670
Value to fishermen	$73,072	$155,004
Number of gallons of oil made	538,623	762,360
Value as sold	$129,539	$168,418
Number of tons of scrap produced	3,810	8,551
Value as sold	$81,010	$166,268

CONNECTICUT.

The river fisheries of this State were investigated to the limits of tidewater except in the case of the Connecticut, which was canvassed for 10 miles above its mouth to Essex.

One of the most noticeable features in the fisheries of Connecticut is the great increase in the oyster industry, which has advanced in value from $386,625 in 1880 to $1,012,259. For details see Notes on the Oyster Industry of Connecticut, vol. IX, Bull. U. S. Fish Commission. As an offset to this there has been an equal or greater decrease in some of the other branches of fishery, notably in the Antarctic fur-seal fishery and the menhaden industry. In the former the fleet has declined from 9 vessels to 1, and in the latter there are now employed only 5 vessels against 72 in 1880. The special table for the menhaden industry shows 8 vessels in the menhaden fishery, but it may be explained that while this number was employed in Connecticut only 5 of them belonged to the State.

There has also been a decrease in the ocean food-fish fisheries, but the shore fisheries have improved materially. As an instance of this, the lobster fishery, which is largely carried on from boats, has increased in value from $27,145 in 1880 to $85,723 in 1888.

The pound-net fishery has grown rapidly, both in apparatus and catch. In 1880 there were only 58 pound nets in the State, but in 1888 there were 118. The fyke-net fishery also shows improvement, there being an increase in this form of apparatus from 255 to 466 in the years named.

57. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	1,035	1,018
On transporting vessels	30	22
In shore fisheries	1,250	1,256
On shore, in factories, packing houses, etc.	709	741
Total	3,024	3,037

58. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing*	218	$547,245	211	$534,300
Outfit		143,100		138,999
Vessels transporting†	12	12,375	10	9,655
Outfit		1,435		1,535
Boats	1,365	103,045	1,354	101,770
Apparatus of capture—vessel fisheries:				
Seines	12	4,960	10	4,310
Lines	790	1,150	760	1,086
Pots	1,965	5,615	2,012	5,830
Dredges, etc		21,600		22,000
Apparatus of capture—shore fisheries:				
Pound nets	120	41,875	118	40,180
Haul seines	52	4,090	46	3,370
Gill nets	67	2,574	61	2,400
Fyke nets	524	2,684	466	2,354
Pots	9,640	19,459	9,662	19,472
Lines		290		280
Spears	220	210	210	198
Dredges, rakes, etc		6,350		6,440
Shore property		1,629,110		1,622,135
Cash capital		350,520		353,000
Total		2,897,687		2,869,314

* Tonnage in 1887, 5,223.96; in 1888, 5,085.90. † Tonnage in 1887, 199.29; in 1888, 168.66.

NOTE.—The following idle vessels are not included in the table: In 1887, 13 vessels, 558.44 tons, valued at $11,030; in 1888, 12 vessels, 420.89 tons, valued at $11,245.

59. *Table of products.*

Species.	Vessel fisheries.			
	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Bluefish	560,416	$31,434	433,847	$22,949
Cod	2,233,839	69,241	1,994,992	64,961
Flatfish and flounders			5,915	127
Haddock	259,726	6,399	237,876	5,851
Hake	1,600	20	1,800	20
Halibut	472,140	34,784	351,340	26,875
Mackerel	21,900	1,490	18,010	1,261
Mackerel, salted	59,280	3,046	24,500	2,100
Menhaden	34,533,300	67,930	37,733,300	76,964
Pollock	13,500	230	13,850	240
Red snapper	330,000	11,000	340,000	11,170
Sea bass	386,390	24,928	243,665	16,139
Squeteague			2,000	75
Striped bass			629	85
Swordfish	104,007	6,338	180,665	10,024
Tautog	54,800	2,598	40,147	2,049
Lobsters	533,320	30,349	578,226	34,183
Quohaugs	6,240	720	2,400	280
Seal skins				*11,200
Whale oil	179,550	10,239	198,450	10,784
Total	39,750,008	300,746	42,401,612	297,337

* The value of 1,600 seal skins.

59. *Table of products*—Continued.

Species.	Shore fisheries.				Total vessel and shore fisheries.			
	1887.		1888.		1887.		1888.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	17, 600	$150	25, 200	$253	17, 600	$150	25, 200	$253
Bluefish	56, 640	3, 971	62, 680	4, 476	617, 056	35, 405	496, 527	27, 425
Butterfish	24, 300	613	38, 100	1, 015	24, 300	613	38, 100	1, 015
Cod	6, 200	325	5, 915	301	2, 240, 039	69, 566	2, 000, 907	65, 262
Cunners	5, 000	200	5, 000	200	5, 000	200	5, 000	200
Eels	326, 650	25, 985	315, 500	25, 270	326, 650	25, 985	315, 500	25, 270
Flounders	554, 000	11, 100	535, 700	10, 591	554, 000	11, 100	541, 615	10, 718
Frostfish or tomcod	123, 100	4, 840	120, 600	4, 492	123, 100	4, 840	120, 600	4, 492
Haddock	5, 700	300	5, 800	275	265, 426	6, 699	243, 676	6, 126
Hake	....	....	....	....	1, 600	20	1. 800	20
Halibut	....	....	....	....	472. 140	34, 784	351, 340	26, 875
Mackerel	19, 800	1, 720	10, 150	1, 015	41, 700	3, 210	28, 160	2, 276
Mackerel, salt	....	....	....	....	59, 280	3, 046	24, 500	2, 100
Menhaden	7, 515, 700	15, 454	6, 233, 760	12, 535	42, 049, 000	83, 384	43, 967, 060	89, 499
Pollock	....	....	....	....	13, 500	230	13, 850	240
Red snappers	....	....	....	....	330, 000	11, 000	340, 000	11, 170
Salmon	430	338	530	426	430	338	530	426
Scup	1, 600	40	2, 400	60	1, 600	40	2, 400	60
Sea bass	38, 065	2, 472	44, 062	2, 917	424, 455	27, 400	287, 727	19, 056
Shad	377, 090	23, 718	282, 077	18, 427	377, 090	23, 718	282, 077	18, 427
Sheepshead	9	2	10	2	9	2	10	2
Smelt	8, 700	782	9, 600	770	8, 700	782	9, 600	770
Squeteague	134, 480	6, 145	258, 560	7, 213	134, 480	6, 145	260, 560	7, 288
Striped bass	45, 600	2, 983	49, 120	3, 489	45, 600	2, 983	49, 749	3, 574
Swordfish	....	....	....	....	104, 007	6, 338	180, 665	10, 024
Tautog	165, 350	7, 690	190, 500	8, 920	220, 150	10, 288	230, 647	10, 969
Whiting	1, 500	30	17, 400	286	1, 500	30	17, 400	286
Miscellaneous	354, 030	2, 782	521, 749	1, 955	354, 030	2, 782	521, 749	1, 955
Lobsters	953, 700	52, 245	899, 000	51, 540	1, 487, 020	82, 594	1, 477, 226	85, 723
Crabs	83, 000	300	83, 000	300	83, 000	300	83, 000	300
Terrapin	3, 015	1, 240	3, 075	1, 290	3, 015	1, 240	3, 075	1, 290
Clams	267, 350	25, 370	265, 750	24, 270	267, 350	25, 370	265, 750	24, 270
Quohaugs	144, 856	17, 957	148, 856	18, 449	151, 096	18, 677	151, 256	18, 729
Scallops	2, 160	201	....	....	2, 160	201	....	....
Oysters*	11, 008, 690	998, 823	10, 569, 069	1, 012, 259	11, 008, 690	998, 823	10, 569, 069	1, 012, 259
Oyster shells†	14, 700, 000	12, 250	12, 900, 000	10, 750	14, 700, 000	12, 250	12, 900, 000	10, 750
Seal skins	....	....	....	....	....	....	....	‡11, 200
Whale oil	....	....	....	....	179, 550	10, 239	198, 450	10, 784
Algæ	18, 300, 000	5, 115	18, 350, 000	4, 976	18, 300, 000	5, 115	18, 350, 000	4, 976
Total	55, 244, 315	1, 225, 141	51, 953, 163	1, 228, 722	94, 994, 323	1, 525, 887	94, 354, 775	1, 526, 059

* Owing to the close connection existing between the shore and the vessel fisheries for oysters, it has been found impracticable to separate them, and for convenience the catch is credited to the shore fishery in the table. In other tables, where it has been necessary to separate them, an allowance of one-half has been made for each fishery.

† The figures given represent only the output of the shell beds in the Housatonic River, in addition to which large quantities of shells were also utilized which do not appear in the table because they have already been included in the value of the oysters. In 1887 the amount handled was 40,632,000 pounds, valued at $36,960; in 1888 the amount was 47,475,000 pounds, valued at $47,445. These quantities represent 812,640 bushels and 949,500 bushels, respectively.

‡ The value of 1,600 seal skins.

60. *Table showing by apparatus and species the yield of the shore fisheries of Connecticut in 1887, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Haul seines.		Pound nets and trap nets.		Gill nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	4,000	$50	13,600	$100		
Bluefish	2,900	230	3,400	195	4,090	$231
Butterfish			24,200	610	100	3
Eels	350	35				
Flatfish and flounders	11,500	265	112,700	1,819		
Frostfish or tomcod	7,600	290	55,000	2,500		
Mackerel			2,900	290	300	30
Menhaden			7,362,000	15,115	87,200	164
Salmon	40	26	140	112	250	200
Scup			1,600	40		
Sea bass			1,515	152		
Shad	71,750	5,166	258,265	15,485	47,075	3,067
Sheepshead			9	2		
Smelt	6,900	642				
Squeteague	4,980	385	101,300	4,080	14,300	880
Striped bass	16,250	1,158	22,400	1,420		
Tautog			12,350	605		
Whiting			1,500	30		
Miscellaneous fish			354,030	2,782		
Total	126,270	8,247	8,326,909	45,337	153,315	4,575

Species.	Fyke nets.		Pots and spears.		Hand lines.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish					46,250	$3,315
Cod					6,200	325
Cunners					5,000	200
Eels			326,300	$25,950		
Flatfish and flounders	353,700	$7,046	19,600	445	56,500	1,525
Frostfish or tomcod	28,000	700			32,500	1,350
Haddock					5,700	300
Mackerel					16,600	1,400
Menhaden	66,500	175				
Sea bass					36,550	2,320
Smelt					1,800	140
Squeteague					13,900	800
Striped bass	6,950	405				
Tautog	7,000	300			146,000	6,785
Total	462,150	8,626	345,900	26,395	367,000	18,460

SUMMARY.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Alewives	17,600	$150	Scup	1,600	$40
Bluefish	56,640	3,971	Sea bass	38,065	2,472
Butterfish	24,300	613	Shad	377,090	23,718
Cod	6,200	325	Sheepshead	9	2
Cunners	5,000	200	Smelt	8,700	782
Eels	326,650	25,985	Squeteague	134,480	6,145
Flatfish and flounders	554,000	11,100	Striped bass	45,600	2,983
Frostfish or tomcod	123,100	4,840	Tautog	165,350	7,690
Haddock	5,700	300	Whiting	1,500	30
Mackerel	19,800	1,720	Miscellaneous fish	354,030	2,782
Menhaden	7,515,700	15,454			
Salmon	430	338	Total	9,781,544	111,640

61. *Table showing by apparatus and species the yield of the shore fisheries of Connecticut in 1888, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Haul seines.		Pound nets and trap nets.		Gill nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives			25,200	$253		
Bluefish	5,900	$430	7,400	361	930	$75
Butterfish			38,100	1,015		
Cod			15	1		
Eels	350	35				
Flatfish and flounders	11,000	245	152,300	2,516		
Frostfish or tomcod	8,900	340	48,400	2,010		
Mackerel			3,050	305	150	15
Menhaden			6,136,700	12,297	31,060	63
Salmon	30	19	200	167	300	240
Scup			2,400	60		
Sea bass			1,812	182		
Shad	27,839	2,210	191,156	12,041	63,082	4,176
Sheepshead			10	2		
Smelt	7,400	620				
Squeteague	4,480	295	228,500	5,350	13,180	818
Striped bass	12,150	874	29,150	2,150	620	60
Tautog			18,000	695		
Whiting			17,400	286		
Miscellaneous fish			521,749	1,955		
Total	78,049	5,068	7,421,542	41,646	109,322	5,447

Species.	Fyke nets.		Pots and spears.		Hand lines.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish					48,450	$3,610
Cod					5,900	300
Cunners					5,000	200
Eels			315,150	$25,235		
Flatfish and flounders	309,300	$6,170	19,100	435	44,000	1,225
Frostfish or tomcod	30,800	792			32,500	1,350
Haddock					5,800	275
Mackerel					6,950	695
Menhaden	66,000	175				
Sea bass					42,250	2,735
Smelt					2,200	150
Squeteague					12,400	750
Striped bass	7,200	405				
Tautog	7,500	325			165,000	7,900
Total	420,800	7,867	334,250	25,670	370,450	19,190

SUMMARY.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Alewives	25,200	$253	Scup	2,400	$60
Bluefish	62,680	4,476	Sea bass	44,062	2,917
Butterfish	38,100	1,015	Shad	282,077	18,427
Cod	5,915	301	Sheepshead	10	2
Cunners	5,000	200	Smelt	9,600	770
Eels	315,500	25,270	Squeteague	258,560	7,213
Flatfish and flounders	535,700	10,591	Striped bass	49,120	3,489
Frostfish or tomcod	120,600	4,492	Tautog	190,500	8,920
Haddock	5,800	275	Whiting	17,400	286
Mackerel	10,150	1,015	Miscellaneous fish	521,749	1,955
Menhaden	6,233,760	12,535			
Salmon	530	426	Total	8,734,413	104,888

Customs districts.	No. of vessels fishing.		Net tonnage.		Value of vessels.		Value of outfit, gear, provisions, fuel, etc.		Number and nationality of fishermen.							
									1887.				1888.			
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	Americans.	British provincials.	All others.	Total.	Americans.	British provincials.	All others.	Total.
Stonington	51	52	1, 401. 59	1, 344. 94	$104, 450	$98, 365	$51, 620	$51, 610	286	....	16	302	274	2	16	292
New London	47	43	1, 407. 16	1, 325. 09	99, 800	91, 435	43, 610	43, 560	245	11	54	310	217	9	71	297
New Haven	41	39	1, 044. 56	1, 050. 62	163, 850	167, 300	42, 103	40, 013	158	9	16	183	162	9	12	183
Fairfield	79	77	1, 370. 65	1, 365. 25	179, 145	177, 200	39, 002	37, 042	214	7	19	240	219	8	19	246
Total	218	211	5, 223. 96	5, 085. 90	547, 245	534, 300	176, 425	172, 225	903	27	105	1, 035	872	28	118	1, 018

Customs districts.	No. of vessels transporting.		Net tonnage.		Value of vessels.		Value of provisions, fuel, etc.		Number and nationality of crew.							
									1887.				1888.			
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	Americans.	British provincials.	All others.	Total.	Americans.	British provincials.	All others.	Total.
Stonington	6	4	98. 87	68. 34	$6, 375	$3, 800	$860	$620	16	....	....	16	8	....	....	8
New London	2	2	35. 75	35. 75	1, 400	1, 400	250	315	4	....	....	4	4	....	....	4
New Haven	4	4	64. 67	64. 57	4, 600	4, 455	325	600	10	....	....	10	10	....	....	10
Fairfield	......	......	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Total	12	10	199. 29	168. 66	12, 375	9, 655	1, 435	1, 535	30	....	....	30	22	....	....	22

63. *Table showing the number of vessels engaged in each fishery in Connecticut in 188 together with their tonnage, value, and number of crew.*

Fishery.	No. of vessels engaged.	Net tonnage.	Value of vessels.	Number and nationality of fishermen.			
				Americans.	British provincials.	All others.	Total
Market	11	462.15	$30,250	58	8	19	8
Halibut	3	161.48	10,500	17	2	9	2
Shore	57	1,169.75	72,305	214	10	25	24
Menhaden	5	365.11	51,600	104	....	....	10
Mackerel	8	155.97	11,825	26	1	6	3
Swordfish	10	150.93	10,700	31	....	2	3
Crustacean	27	296.21	21,840	68	....	3	7
Mollusk	116	2,415.87	218,500	381	11	37	42
Whale and seal	4	384.87	17,300	68	14	....	8

64. *Table showing by fisheries and species the yield of the vessel fisheries of Connecticu in* 1888.

[This table does not include the products of the whale and seal fisheries. During 1888 the whal products landed amounted to $10,784, and the seal fishery yielded skins worth $11,200.]

Fisheries and species.	Pounds.	Value.	Fisheries and species.	Pounds.	Value.
Shore:			Mackerel:		
Bluefish	433,847	$22,949	Mackerel	18,010	$1,26
Cod	1,346,992	44,815	Mackerel, salted	24,500	2,10
Flatfish and flounders	5,915	127			
Haddock	152,876	3,781	Total	42,510	3,36
Hake	1,800	20			
Halibut	88,540	6,650			
Pollock	13,850	240			
Sea bass	243,665	16,139	Halibut	161,800	12,04
Squeteague	2,000	75	Menhaden	37,733,300	76,96
Striped bass	629	85	Swordfish	179,343	9,93
Swordfish	1,322	87	Lobster	578,226	34,18
Tautog	40,147	2,049			
Total	2,331,583	97,017	Mollusk:		
			Quohaugs	2,400	28
Market:			Oysters	5,284,534	506,12
Cod	648,000	20,146			
Haddock	85,000	2,070	Total	5,286,934	506,40
Halibut	101,000	8,185			
Red snapper	340,000	11,170			
			Grand total	47,487,696	781,48
Total	1,174,000	41,571			

65. *Table showing the extent of the menhaden industry of Connecticut.*

Designation.	1887.	1888.
Number of factories in operation	3	
Value of factories	$34,200	$34,20
Amount of cash capital	$16,000	$16,20
Number of shoresmen employed	53	5
Number of fishermen employed	141	11
Number of steam vessels employed	7	
Net tonnage	487.49	365.1
Value	$65,300	$51,60
Value of outfit	$10,800	$8,50
Number of sailing vessels employed as "carryaways"	3	
Net tonnage	30.51	30.5
Value	$1,500	$1,43
Value of outfit	$240	$24
Number of menhaden handled	54,000,000	59,620,00
Value to fishermen	$71,133	$80,99
Number of gallons of oil made	94,380	143,60
Value as sold	$24,155	$37,96
Number of tons of scrap produced	1,245	1,84
Value as sold	$23,310	$30,57

IV.—FISHERIES OF THE MIDDLE ATLANTIC STATES.

The States of New York, New Jersey, Pennsylvania, Delaware, Maryland, and Virginia have been included in this section, which has a coast line of about 5,400 miles, divided as follows: New York, 890 miles; New Jersey, 780 miles; Pennsylvania, 235 miles; Delaware, 180 miles; Maryland, 2,170 miles; Virginia, 1,145 miles.

Three large indentations occur along this coast, which are the centers of fisheries of great extent; these are Princess, Delaware, and Chesapeake Bays, the latter being the most prolific fishing ground of like proportions in the world. The fisheries of this region surpass those of any other section, the value of the catch exceeding that of the New England States by more than $2,500,000, and of the Pacific States by over $7,000,000.

This division is the center of the greatest molluscan fisheries of the world, and it is largely owing to them that it has attained its high rank, although the fisheries for other aquatic products are also extensive and second only to those of New England.

The characteristic vessel fisheries of the region are for bluefish and sea bass, carried on chiefly from Greenport, New York, and Philadelphia, Pennsylvania; for oysters in the bays already named; for clams in Princess Bay; and for menhaden, this fishery being particularly important in Long Island, in northern New Jersey, and in the Chesapeake Bay.

The shore fisheries are more important than in any other section, those for oysters, clams, crabs, and anadromous fish being particularly extensive.

The fisheries of the Middle States gave employment in 1888 to 66,204 persons, of whom 18,228 were vessel fishermen, 35,503 shore fishermen, and 12,473 shoresmen, preparators, and factory hands.

Of the capital invested, amounting to $16,028,688, $4,843,558 represented vessels, $1,215,082 boats, $1,282,079 apparatus of capture, and $8,687,969 shore property and cash capital.

The yield of the fisheries was valued at $13,749,312 at first hand, of which amount about three-fourths was the value of oysters and other mollusks.

NEW YORK.

The fishery interests of this State bordering on salt water are included in the tables. The Hudson River was canvassed to a point a few miles above Yonkers. The fisheries above that place have not been embraced in the tables. Reliable data give about 600 persons in the region not covered by the tables, with boats and apparatus worth $24,500; the catch, consisting chiefly of shad, was valued at $113,031.

Some of the fisheries of New York have undergone marked changes since 1880, while others have remained in about the same condition. There has been a substantial advance since 1880 in the number of persons employed and in the amount of invested capital. Especially worthy of mention is the large increase in the fleet of fishing vessels, which numbered 541 sail in 1880 and 738 in 1888.

Notwithstanding the improvement in the fisheries in the respects noted, the products show a decline in value of 8 per cent. The menhaden and soft-clam industries exhibit the most pronounced decrease, while the oyster fishery shows an improvement. Omitting the menhaden fishery, the figures for this State indicate a substantial gain over 1880.

66. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	1,725	1,913
On transporting vessels	331	343
On boats	3,592	3,608
On shore, in factories, packing houses, etc	1,143	1,193
Total	6,796	7,057

67. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels, fishing*	552	$744,900	592	$837,540
Outfit		231,470		256,340
Vessels, transporting†	141	156,100	146	162,675
Outfit		36,210		37,415
Boats	3,519	204,535	3,590	210,805
Apparatus of capture—vessel fisheries:				
Seines	55	26,400	64	30,720
Lines	4,420	6,980	4,610	7,196
Dredges, rakes, etc		21,050		22,020
Apparatus of capture—shore fisheries:				
Pound nets	182	46,565	199	49,835
Haul seines	194	13,122	203	13,160
Gill nets	821	32,575	812	31,488
Fyke nets	3,638	19,787	3,975	21,301
Pots	16,773	14,624	17,680	16,040
Lines		3,170		3,280
Spears		600		600
Dredges, rakes, etc		10,400		10,750
Shore property, factories, packing houses, etc		1,166,210		1,196,180
Cash capital		1,535,450		1,620,150
Total		4,269,848		4,527,489

*Tonnage in 1887, 7,052.49; in 1888, 7,825.34.

†Tonnage in 1887, 2,086.99; in 1888, 2,228.59.

68. *Table of products.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
lewives	249, 800	$2, 800	223, 000	$2, 670
uefish	2, 852, 310	175, 745	3, 454, 470	199, 016
onito	20, 600	814	18, 600	690
atterfish	329, 000	10, 385	264, 000	7, 505
atfish	20, 220	1, 355	33, 100	2, 255
od	3, 455, 240	114, 435	3, 194, 960	103, 985
els	1, 218, 730	94, 196	1, 198, 040	93, 617
ounders	1, 722, 380	61, 017	1, 736, 950	63, 847
alibut	11, 160	645	10, 000	560
ingfish	79, 270	7, 670	78, 440	7, 528
ackerel	7, 300	805	6, 100	780
enhaden	71, 048, 370	166, 409	134, 840, 850	314, 118
innows	347, 400	2, 095	563, 000	2, 435
ullet	22, 000	1, 230	12, 000	740
erch	252, 015	12, 626	197, 325	13, 461
ke	2, 300	201	2, 000	165
a bass	319, 420	26, 600	308, 900	27, 205
a-robins	250, 300	698	500, 000	650
ad*	627, 190	24, 051	599, 425	24, 795
anish mackerel	5, 330	1, 140	7, 520	1, 110
queteague or weakfish	1, 504, 560	82, 587	1, 434, 870	79, 506
riped bass	115, 380	11, 059	97, 840	9, 726
urgeon	9, 600	530	9, 800	600
autog	150, 000	7, 814	150, 750	8, 190
omcod or frostfish	129, 950	5, 011	131, 800	5, 205
iscellaneous fish	192, 540	7, 430	175, 700	6, 625
efuse fish	7, 933, 300	12, 300	7, 366, 000	11, 040
errapin	5, 808	1, 740	4, 215	1, 230
ysters	13, 903, 050	1, 974, 625	13, 307, 840	1, 893, 085
ams (soft)	415, 600	43, 105	413, 000	42, 695
uohaugs or round clams	2, 673, 960	296, 040	2, 593, 520	289, 360
callops	316, 785	55, 597	199, 815	48, 640
hells	15, 075, 000	14, 400	14, 085, 000	13, 100
ussels	845, 250	10, 026	891, 660	10, 787
obsters	114, 000	6, 850	248, 000	13, 900
rabs	982, 600	35, 080	1, 287, 000	44, 340
ing crabs	22, 000	115	21, 000	110
hales		4, 060		2, 580
Total	127, 329, 718	3, 273, 286	189, 666, 490	3, 347, 851

* Includes the catch in the Hudson River only as far as Yonkers. The yield of the entire State was 585,740 pounds in 1887, and 3,445,639 pounds in 1888.

69. *Table showing by customs districts the vessel fisheries of New York in* 1887 *and* 1888.

Designation.	Sag Harbor.		New York.		Total.	
	1887.	1888.	1887.	1888.	1887.	1888.
umber and nationality of fishermen:						
Americans	499	615	1, 108	1, 175	1, 607	1, 790
Swedes	26	29	12	13	38	42
Portuguese	11	11	11	12	22	23
All others	13	13	45	45	58	58
Total	549	668	1, 176	1, 245	1, 725	1, 913
umber and nationality of crews on transports:						
Americans	77	74	244	258	321	332
Swedes	3	4	1	1	4	5
Portuguese	1	1	1	1	2	2
All others	1	1	3	3	4	4
Total	82	80	249	263	331	343
umber of vessels fishing	78	92	474	500	552	592
umber of vessels transporting	29	28	112	118	141	146
et tonnage of vessels fishing	1, 973. 84	2, 440. 27	5, 078. 65	5, 385. 07	7, 052. 49	7, 825. 34
et tonnage of vessels transporting	319. 16	303. 25	1, 767. 83	1, 925. 34	2, 086. 99	2, 228. 59
alue of vessels fishing	231, 150	290, 925	513, 750	546, 615	744. 900	837, 540
alue of vessels transporting	23, 100	20, 625	133, 000	142, 050	156, 100	162, 675
alue of outfit, gear, provisions, fuel, etc., of vessels fishing	102, 550	123, 365	183, 050	192, 905	285, 600	316, 270
alue of provisions, fuel, etc., of vessels transporting	9, 255	8, 990	26, 955	28, 425	36, 210	37, 415
alue of catch of vessels fishing	395, 210	514, 804	1, 228, 483	1, 204, 160	1, 623, 693	1, 748, 964
alue of products transported	87, 950	81, 840	369, 600	376, 940	457, 550	458, 780

70. *Table showing by species and apparatus the yield of the fisheries of New York in* 1887, *exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Seines.		Gill nets.		Pound nets.		Fyke nets.	
	Pounds	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	175,000	$1,950	5,000	$55	54,000	$615	15,800	$180
Bluefish	192,090	12,030	454,670	27,110	564,460	34,925	14,700	890
Bonito	5,000	198			7,800	286		
Butterfish					326,000	10,235	3,000	150
Catfish	3,260	230	4,210	325			5,300	290
Eels	79,705	5,180						
Flounders	118,780	4,128	7,350	256	227,410	7,914	1,088,900	38,495
Halibut								
Kingfish	21,050	2,245	17,000	1,782	28,400	2,554	520	44
Mackerel					3,600	395		
Menhaden	68,936,450	160,832	12,000	55	2,046,600	5,322	53,320	200
Minnows	344,500	1,935						
Mullet	22,000	1,230						
Perch	139,300	6,825	62,565	3,170	2,450	156	43,700	2,225
Pike			2,000	175			300	26
Sea bass	46,560	3,645	31,300	2,552	98,600	6,895		
Sea-robins	117,300	218			233,000	480		
Shad			328,440	12,365	131,600	6,221	167,150	5,465
Spanish mackerel	930	160			2,600	580		
Squeteague or weakfish	281,860	14,274	382,360	20,984	392,720	23,526	66,450	2,908
Striped bass	20,680	1,760	29,120	2,346	8,750	860	28,230	2,973
Sturgeon					9,600	530		
Tautog	4,250	254	12,400	688	27,100	1,600	7,650	398
Tomcod or frostfish	2,250	120	4,500	230	8,600	465	60,200	1,936
Miscellaneous species	46,000	1,480	28,400	915	34,620	1,260	21,200	935
Refuse fish					7,800,000	12,100	133,300	200
Total	70,556,965	218,694	1,381,315	73,008	12,007,910	116,919	1,709,720	57,315

Species.	Lines.		Pots.		Spears.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives							249,800	$2,800
Bluefish	1,626,390	$100,790					2,852,310	175,745
Bonito	7,800	330					20,600	814
Butterfish							329,000	10,385
Catfish	7,450	510					20,220	1,355
Cod	3,455,240	114,435					3,455,240	114,435
Eels			879,705	$66,040	259,320	$22,976	1,218,730	94,196
Flounders	154,640	6,720			125,300	3,504	1,722,380	61,017
Halibut	11,160	645					11,160	645
Kingfish	12,300	1,045					79,270	7,670
Mackerel	3,700	410					7,300	805
Menhaden							71,048,370	166,409
Minnows	2,900	160					347,400	2,095
Mullet							22,000	1,230
Perch	4,000	250					252,015	12,626
Pike							2,300	201
Sea bass	142,960	13,508					319,420	26,600
Sea-robins							250,300	698
Shad							627,190	24,051
Spanish mackerel	1,800	400					5,330	1,140
Squeteague or weakfish	381,170	20,895					1,504,560	82,587
Striped bass	28,600	3,112					115,380	11,059
Sturgeon							9,600	530
Tautog	98,600	4,874					150,000	7,814
Tomcod or frostfish	54,400	2,260					129,950	5,011
Miscellaneous species	62,320	2,840					192,540	7,430
Refuse fish							7,933,300	12,300
Total	6,055,430	273,192	879,705	66,040	384,620	26,480	92,975,665	831,648

71. *Table showing by species and apparatus the yield of fisheries of New York in 1888, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Seines.		Gill nets.		Pound nets.		Fyke nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	160,000	$1,940			48,000	$550	15,000	$180
Bluefish	225,410	13,916	490,460	$30,450	568,140	34,480	17,700	1,015
Bonito	5,200	205			4,200	180		
Butterfish					261,000	7,340	3,000	165
Catfish	8,000	585	4,000	260	8,000	560	6,500	465
Cod								
Eels	64,800	4,592						
Flounders	115,300	4,140	32,410	1,068	237,200	8,364	1,092,400	39,700
Halibut								
Kingfish	21,000	2,160	18,700	1,898	28,600	2,575	740	70
Mackerel	1,600	180	700	80	1,400	180		
Menhaden	132,252,600	308,098	20,000	90	2,146,600	5,180	421,650	750
Minnows	563,000	2,435						
Mullet	12,000	740						
Perch	87,700	6,490	69,125	4,340	6,500	435	30,600	1,956
Pike			2,000	165				
Sea bass	45,400	4,150	24,700	2,135	90,100	6,850	2,500	210
Sea-robins	200,000	250			300,000	400		
Shad			307,700	13,015	137,550	6,440	154,175	5,340
Spanish mackerel	1,020	170			4,100	540		
Squeteague or weakfish	296,900	15,345	334,000	18,556	366,920	21,790	60,950	2,985
Striped bass	7,440	760	17,600	1,546	9,100	915	28,800	2,890
Sturgeon					9,800	600		
Tautog	4,000	260	11,400	760	25,300	1,740	7,750	470
Tomcod or frostfish	2,400	120	4,000	225	8,300	400	61,200	1,980
Miscellaneous species	44,500	1,770	28,200	560	22,000	910	19,000	755
Refuse fish					7,226,000	10,840	140,000	200
Total	134,118,270	368,306	1,364,995	75,148	11,508,810	111,269	2,061,965	59,131

Species.	Lines.		Pots.		Spears.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives							223,000	$2,670
Bluefish	2,152,760	$119,155					3,454,470	199,016
Bonito	9,200	305					18,600	690
Butterfish							264,000	7,505
Catfish	6,600	385					33,100	2,255
Cod	3,194,960	103,985					3,194,960	103,985
Eels			868,810	$66,120	264,430	$22,905	1,198,040	93,617
Flounders	148,740	6,525			110,900	4,050	1,736,950	63,847
Halibut	10,000	560					10,000	560
Kingfish	9,400	825					78,440	7,528
Mackerel	2,400	340					6,100	780
Menhaden							134,840,850	314,118
Minnows							563,000	2,435
Mullet							12,000	740
Perch	3,400	240					197,325	13,461
Pike							2,000	165
Sea bass	146,200	13,860					308,900	27,205
Sea-robins							500,000	650
Shad							599,425	24,795
Spanish mackerel	2,400	400					7,520	1,110
Squeteague or weakfish	376,100	20,830					1,434,870	79,506
Striped bass	34,900	3,615					97,840	9,726
Sturgeon							9,800	600
Tautog	102,300	4,960					150,750	8,190
Tomcod or frostfish	55,900	2,480					131,800	5,205
Miscellaneous species	62,000	2,630					175,700	6,625
Refuse fish							7,366,000	11,040
Total	6,317,260	281,095	868,810	66,120	375,330	26,955	156,615,440	988,024

72. *Table showing the extent of the menhaden industry of New York.*

Designation.	1887.	1888.
Number of factories in operation	11	11
Value of factories	$177,500	$203,300
Amount of cash capital	$129,000	$197,000
Number of shoresmen employed	428	465
Number of fishermen employed	378	451
Number of steam vessels employed	18	22
Net tonnage	978.90	1,206.39
Value	$176,000	$218,750
Value of outfit	$40,050	$48,730
Number of sailing vessels employed in fishing	5	5
Net tonnage	92.78	92.08
Value	$6,400	$6,150
Value of outfit	$4,380	$4,300
Number of sailing vessels employed as "carryaways"	5	6
Net tonnage	62.65	69.55
Value	$3,900	$4,500
Value of outfit	$350	$425
Number of menhaden handled	114,633,200	219,970,910
Value to fishermen	$166,409	$314,118
Number of gallons of oil made	814,671	1,248,008
Value as sold	$170,979	$349,454
Number of tons of scrap produced	8,686	20,560
Value as sold	$198,976	$421,835

Three factories idle in 1887 and 1888 are not included in the above figures. The value of these was $33,000 in 1887 and $22,000 in 1888. Four steamers, valued at $45,000, of 227.49 tons burden, that were idle in 1887, are also omitted.

NEW JERSEY.

In this State the figures submitted cover all the fisheries, the rivers having been canvassed as high as commercial fishing was prosecuted.

In many respects the fisheries of New Jersey show a gratifying improvement since 1880. There has been comparatively little increase in capital, because the development has been chiefly in the shore fisheries. In persons employed there has been an increase of more than 4,000.

Among the most noteworthy changes may be mentioned the sturgeon fishery, which has grown to large proportions, its yield being more than tenfold what it was in 1880. The shad fishery has likewise increased enormously—from 750,000 pounds, worth $35,000 in 1880, to 6,521,447 pounds, with a value of $307,411 in 1888—a result that is attributed to the beneficial effect of artificial propagation. There has also been a marked advance in the shellfish fishery, resulting in placing this State at the head of the list in this particular industry.

The hook-and-line shore fishery for bluefish and sea bass is more important than in any other State. The pound-net fishery has developed considerably, there being 127 pound nets in 1888 against only 27 in 1880. There has been a decline in the menhaden industry, the value of manufactured products in 1888 being less than half what it was in 1880. The same can be said of the crab fishery, which, in the last year covered by these statistics yielded only about one-third what it was credited with in the census year. Among the elements contributing to the success of the shore fisheries in this State may properly be included the great seaside resorts that have grown up on the coast, and which take large quantities of fish during the summer.

73. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	1,783	1,727
On transporting vessels	238	213
In shore fisheries	7,747	8,112
On shore—in factories, etc	438	424
Total	10,206	10,476

74. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing*	502	$511,375	504	$488,535
Outfit		50,159		45,632
Vessels transporting†	88	107,800	74	100,850
Outfit		5,705		5,385
Boats	4,894	335,673	5,257	354,325
Apparatus of capture—vessel fisheries:				
Seines	11	4,405	10	3,400
Gill nets	12	120		
Lines and trawls		53		62
Pots	90	68	295	265
Dredges, tongs, and rakes	931	34,964	1,103	41,053
Apparatus of capture—shore fisheries:				
Seines	401	38,390	414	39,535
Gill nets	2,830	135,232	2,963	138,693
Pound nets and weirs	84	19,911	136	25,979
Fyke nets	1,499	14,404	1,615	14,876
Pots	3,755	3,935	4,204	4,329
Tongs, rakes, etc	3,200	18,871	3,309	19,341
Lines and trawls	20	2,107	20	2,165
Spears	132	151	136	159
Crabbing outfits	269	198	268	197
Shore property		215,733		201,054
Cash capital		67,300		59,000
Total		1,566,554		1,544,835

* Tonnage in 1887, 7,300.85; in 1888, 7,195.06. † Tonnage in 1887, 1,602.23; in 1888, 1,513.08.

75. *Table of products by vessel and shore fisheries.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Vessel fisheries:				
Bluefish	39,100	2,317	51,485	2,630
Cod	151,608	5,744	72,095	2,180
Eels	8,100	492	21,600	1,140
Menhaden	8,777,400	24,690	3,975,000	7,885
Sea bass	248,083	11,325	283,567	11,667
Clams (*Venus mercenaria*)	663,024	53,992	786,176	66,302
Oysters	5,371,831	592,518	4,472,342	482,671
Crabs, hard	36,556	1,097	21,867	710
Lobsters			90,453	6,112
Shrimp			105	5
Total	15,295,672	692,175	9,774,690	581,302
Shore fisheries:				
Alewives	2,686,818	27,039	2,717,520	26,924
Bluefish	4,748,182	202,248	4,605,955	194,371
Bluefish, salted	2,000	100	3,500	175
Cod	636,000	12,488	654,500	13,260
Catfish	120,729	5,484	119,427	5,356
Drum	42,000	1,300	43,500	1,350
Eels	864,828	66,212	773,845	60,467
Flounders and flatfish	367,109	15,621	416,232	18,238
Hake	4,500	225	12,140	580
Kingfish	48,140	3,925	58,395	4,857

75. *Table of products by vessel and shore fisheries*—Continued.

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Shore fisheries—Continued.				
Menhaden	5, 259, 840	$8, 119	5, 070, 120	$7, 890
Menhaden, salted	19, 600	280	22, 400	320
Mullet, salted	1, 500	90	....	....
Pike and pickerel	27, 625	1, 850	30, 400	2, 066
Perch	692, 520	37, 235	795, 324	40, 976
Sea bass	570, 570	22, 163	532, 050	21, 004
Shad	6, 494, 957	308, 147	6, 523, 447	307, 411
Sturgeon	3, 294, 550	42, 740	3, 681, 475	48, 453
Suckers	141, 142	5, 598	121, 642	4, 868
Striped bass	614, 847	69, 402	739, 122	84, 404
Sheepshead	61, 820	7, 105	33, 711	3, 425
Spanish mackerel	46, 200	9, 240	67, 150	13, 150
Weakfish	2, 376, 711	87, 475	2, 845, 103	101, 324
Miscellaneous fish	149, 437	5, 849	165, 909	5, 890
Clams	3, 562, 346	784, 103	3, 598, 476	814, 106
Oysters	12, 964, 980	1, 677, 493	13, 199, 235	1, 762, 988
Crabs, hard	1, 232, 000	19, 224	1, 193, 333	18, 765
Crabs, soft	220, 184	39, 375	215, 920	38, 615
Crabs, king (*Limulus*)	2, 592, 000	6, 480	3, 004, 000	7, 510
Lobsters	101, 580	7, 719	91, 235	6, 853
Terrapin	5, 844	1, 620	5, 900	1, 652
Total	49, 950, 559	3, 475, 949	51, 340, 972	3, 617, 248
Total vessel and shore fisheries:				
Alewives	2, 686, 818	27, 039	2, 717, 520	26, 924
Bluefish	4, 787, 282	204, 565	4, 657, 440	197, 001
Bluefish, salted	2, 000	100	3, 500	175
Cod	787, 608	18, 232	726, 595	15, 440
Catfish	120, 729	5, 484	119, 427	5, 356
Drum	42, 000	1, 300	43, 500	1, 350
Eels	872, 928	66, 704	795, 445	61, 607
Flounders and flatfish	367, 109	15, 621	416, 238	18, 238
Hake	4, 500	225	12, 140	580
Kingfish	48, 140	3, 925	58, 395	4, 857
Menhaden	14, 037, 240	32, 809	9, 045, 120	15, 775
Menhaden, salted	19, 600	280	22, 400	320
Mullet, salted	1, 500	90	....	....
Pike and pickerel	27, 625	1, 850	30, 400	2, 066
Perch	692, 520	37, 235	795, 324	40, 976
Sea bass	818, 653	33, 488	815, 617	32, 671
Shad	6, 494, 957	308, 147	6, 523, 447	307, 411
Sturgeon	3, 294, 550	42, 740	3, 681, 475	48, 453
Suckers	141, 142	5, 598	121, 642	4, 868
Striped bass	614, 847	69, 402	739, 122	84, 404
Sheepshead	61, 820	7, 105	33, 711	3, 425
Spanish mackerel	46, 200	9, 240	67, 150	13, 150
Weakfish	2, 376, 711	87, 475	2, 845, 103	101, 324
Miscellaneous fish	149, 437	5, 849	165, 909	5, 890
Clams	4, 225, 370	838, 095	4, 384, 652	880, 408
Oysters	18, 336, 781	2, 270, 011	17, 671, 577	2, 245, 659
Crabs, hard	1, 268, 556	20, 321	1, 215, 200	19, 475
Crabs, soft	220, 184	39, 375	215, 920	38, 615
Crabs, king (*Limulus*)	2, 592, 000	6, 480	3, 004, 000	7, 510
Lobsters	101, 580	7, 719	181, 688	12, 965
Shrimp	....	....	105	5
Terrapin	5, 844	1, 620	5, 900	1, 652
Total	65, 246, 231	4, 168, 124	61, 115, 662	4, 198, 550

76. *Table of secondary products.*

Designation.	1887.		1888.	
	Quantity.	Value.	Quantity.	Value.
Oil (menhaden and sturgeon oil) .... gallons..	186, 600	$41, 199	96, 768	$28, 514
Fertilizer (menhaden, sturgeon, and king-crab) .... tons..	3, 593	84, 455	3, 778	76, 535
Caviare .... pounds..	238, 000	28, 200	261, 750	37, 380
Total	....	153, 854	....	142, 429

77. Table showing by customs districts the extent of the vessel fisheries of New Jersey in 1887 and 1888.

Customs districts.	No. of vessels fishing.		Net tonnage.		Value of vessels.		Value of outfit, gear, provisions, fuel, etc.		Number and nationality of fishermen.						Value of catch.	
									1887.			1888.				
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	American, white.	American, colored.	Total.	American, white.	American, colored.	Total.	1887.	1888.
Perth Amboy	135	153	1,304.81	1,401.38	$77,450	$90,975	$15,375	$16,505	312	....	312	331	1	332	$166,260	$150,745
Little Egg Harbor	7	7	79.29	79.29	5,200	5,200	2,015	1,605	22	....	22	22	....	22	7,226	3,021
Great Egg Harbor	19	17	336.46	292.97	41,400	23,700	4,955	3,210	91	....	91	65	....	65	33,857	19,851
Bridgeton	313	297	5,024.94	4,836.87	340,425	320,210	60,738	57,990	1,217	1	1,218	1,155	....	1,155	422,322	346,806
Camden	27	28	541.44	555.23	46,000	47,050	6,586	7,075	137	....	137	145	....	145	61,710	59,129
Burlington	1	2	13.91	29.32	900	1,400	100	300	3	....	3	8	....	8	800	1,750
Total	502	504	7,300.85	7,195.06	511,375	488,535	89,769	86,685	1,782	1	1,783	1,726	1	1,727	692,175	581,302

Customs districts.	No. of vessels transporting.		Net tonnage.		Value of vessels.		Value of provisions, fuel, etc.		Number and nationality of crew.						Value of products transported.	
									1887.			1888.				
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	American, white.	American, colored.	Total.	American, white.	American, colored.	Total.	1887.	1888.
Perth Amboy	25	17	278.75	250.26	$20,900	$17,250	$1,335	$1,000	51	1	52	40	....	40	$190,891	$172,883
Little Egg Harbor	14	10	277.35	108.42	24,000	17,000	1,125	875	35	....	35	27	....	27	49,700	28,671
Great Egg Harbor	23	24	479.83	533.10	34,400	38,000	1,560	1,650	63	....	63	62	4	66	46,732	41,449
Bridgeton	13	11	288.70	303.06	14,100	18,300	875	985	49	....	49	44	....	44	22,307	15,575
Camden	13	12	277.60	228.24	14,400	10,200	810	875	39	....	39	36	....	36	56,291	81,777
Burlington	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Total	88	74	1,602.23	1,513.08	107,800	100,850	5,705	5,385	237	1	238	209	4	213	365,921	340,355

78. *Table showing by apparatus and species the yield of the shore fisheries of New Jersey in 1888, exclusive of the shellfish, terrapin, crab, and lobster fisheries.*

Species.	Hand lines and trawl lines.		Haul seines.		Gill nets.		Pound nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives, fresh			2, 469, 420	$24, 152	243, 500	$2, 680		
Bluefish, fresh	3, 654, 400	$152, 775	409, 906	16, 152	300, 724	15, 737	240, 925	$9, 707
Bluefish, salted					3, 500	175		
Black bass, fresh	139	25						
Butterfish, fresh			4, 000	200				
Cod, fresh	654, 500	13, 260						
Catfish, fresh	26, 298	1, 162	48, 865	2, 270	5, 500	270		
Chub, fresh					3, 625	145		
Drum, fresh	43, 500	1, 350						
Eels, fresh	33, 062	2, 514	80, 400	7, 310				
Flounders, fresh	1, 667	50	57, 842	3, 080	66, 070	3, 964		
Goody, fresh			4, 047	202				
Hake, fresh			12, 140	580				
Kingfish, fresh	16, 100	1, 127	31, 875	3, 188	10, 420	542		
Menhaden, fresh			762, 000	635	673, 200	920	3, 634, 920	6, 335
Menhaden, salted					22, 400	320		
Pike and pickerel, fresh			25, 400	1, 666	5, 000	400		
Perch, fresh	850	50	465, 533	25, 339	195, 641	11, 429		
Salmon, fresh					30	13		
Sea bass, fresh	530, 050	20, 904			2, 000	100		
Shad, fresh			928, 537	54, 166	4, 997, 527	228, 719	249, 428	11, 099
Sheepshead, fresh	30, 841	2, 976	120	24	250	50	2, 500	375
Spanish mackerel, fresh					22, 400	4, 480	44, 750	8, 650
Striped bass, fresh	10, 143	1, 116	562, 417	67, 980	106, 025	9, 303	2, 700	216
Sturgeon, fresh					3, 681, 4 5	48, 453		
Suckers, fresh			118, 642	4, 748	3, 000	120		
Squeteague, fresh	623, 785	28, 011	1, 403, 994	51, 561	50, 882	2, 298	730, 756	18, 193
Miscellaneous, fresh			25, 470	513	11, 660	350	116, 608	4, 242
Total	5, 625, 335	225, 320	7, 410, 608	263, 766	10, 404, 829	330, 468	5, 022, 587	58, 817

Species.	Fyke nets.		Pots, traps, etc.		Spears.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives, fresh	4, 600	$92					2, 717, 520	$26, 924
Bluefish, fresh							4, 605, 955	194, 371
Bluefish, salted							3, 500	175
Black bass, fresh							139	25
Butterfish, fresh							4, 000	200
Cod, fresh							654, 500	13, 260
Catfish, fresh	38, 764	1, 654					119, 427	5, 356
Chub, fresh							3, 625	145
Drum, fresh							43, 500	1, 350
Eels, fresh	32, 316	3, 350	608, 017	$45, 694	20, 050	$1, 599	773, 845	60, 467
Flounders, fresh	290, 659	11, 144					416, 238	18, 238
Goody, fresh							4, 047	202
Hake, fresh							12, 140	580
Kingfish, fresh							58, 395	4, 857
Menhaden, fresh							5, 070, 120	7, 890
Menhaden, salted							22, 400	320
Pike and pickerel, fresh							30, 400	2, 066
Perch, fresh	133, 300	4, 158					795, 324	40, 976
Salmon, fresh	330	200					360	213
Sea bass, fresh							532, 050	21, 004
Shad, fresh	347, 955	13, 427					6, 523, 447	307, 411
Sheepshead, fresh							33, 711	3, 425
Spanish mackerel, fresh							67, 150	13, 150
Striped bass, fresh	57, 837	5, 789					739, 122	84, 404
Sturgeon, fresh							3, 681, 475	48, 453
Suckers, fresh							121, 642	4, 868
Squeteague, fresh	35, 686	1, 261					2, 845, 103	101, 324
Miscellaneous, fresh							153, 738	5, 105
Total	941, 447	41, 075	608, 017	45, 694	20, 050	1, 599	30, 032, 873	966, 759

79. *Table showing the extent of the menhaden industry of New Jersey.*

Designation.	1887.	1888.
Number of factories in operation	8	7
Value of factories	$89,800	$73,800
Amount of cash capital	$57,300	$49,000
Number of shoresmen employed	116	92
Number of fishermen employed	139	110
Number of steam vessels employed	5	3
Net tonnage	186.70	114.25
Value	$47,500	$27,000
Value of outfit	$8,250	$4,950
Number of sailing vessels employed in fishing	6	6
Net tonnage	116.79	120.96
Value	$4,800	$5,800
Value of outfit	$6,830	$5,750
Number of sailing vessels employed as "carryaways"	10	9
Net tonnage	126.21	105.77
Value	$6,650	$6,250
Value of outfit	$710	$650
Number of menhaden handled	27,915,000	27,252,000
Value to fishermen	$31,265	$30,512
Number of gallons of oil made	176,600	86,768
Value as sold	$38,899	$26,214
Number of tons of scrap produced	2,243	2,478
Value as sold	$47,455	$41,035

PENNSYLVANIA.

The data given for this State include, besides the salt-water fisheries, the figures for the Susquehanna River as far as York and Lancaster Counties, and the Delaware River to the limits of commercial fishing.

There has been a phenomenal increase in some branches, especially in the vessel fishery. In 1880 11 vessels were credited to the State, and these were employed only in the fishery for sea bass; in 1888 there were 81 vessels engaged in different branches, including sea bass, menhaden, and oyster, a very prominent feature at present being the large number of vessels composing the oyster fleet.

While the number of persons employed has increased from 552 to 2,011, the improvement is most marked in the item of capital invested, which is tenfold more than in the census year, as follows: $119,801 in 1880 and $1,227,166 in 1888. It is probable that this showing is due to some extent to the fact that the canvass for 1888 included cash capital and other property invested in the wholesale fish trade, of which it is not apparent that account was taken by the census. But even if cash capital and shore property be omitted from consideration, there is still an increase in value of more than 200 per cent.

The value of the catch has increased nearly 300 per cent., while the quantity has advanced from 1,680,000 pounds in 1880 to 12,900,670 in 1888, the latter figure including 7,611,200 pounds of menhaden. Two steamers belonging to this State engage in the menhaden fishery, but land their catch in New Jersey. There was no menhaden fishery from Pennsylvania in 1880.

The mackerel, cod, and haddock credited to Pennsylvania were taken by the schooner *Roulette* of Philadelphia, which fitted from and marketed her catch at Boston, Massachusetts.

80. *Table of persons employed.*

How engaged.	1887.	1888.
In vessel fisheries	442	500
On transporting vessels	24	29
In shore fisheries	*1,143	*1,174
On shore	311	308
Total	1,920	2,011

* Including 270 persons in 1887 and 267 in 1888, who are to be classed as semi-professional.

81. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing*	67	$155,950	72	$156,000
Outfit		21,096		23,470
Vessels transporting†	6	8,400	9	11,350
Outfit		375		450
Boats	369	14,845	374	15,120
Apparatus of capture—vessel fisheries:				
Purse seines	4	2,000	4	2,200
Gill nets			8	80
Lines and trawls		259		310
Dredges and rakes	358	7,140	384	7,680
Apparatus of capture—shore fisheries:				
Seines	85	6,398	90	6,600
Gill nets	190	18,670	182	19,000
Fyke nets, drop fykes, etc	1,947	4,391	2,077	4,651
Lines		154		160
Baskets	262	2,470	262	2,470
Dip nets	86	175	86	175
Shore property		395,175		380,450
Cash capital		590,000		597,000
Total investment		1,227,498		1,227,166

* Tonnage in 1887, 1,700.24; in 1888, 1,793.34. † Tonnage in 1887, 113.33; in 1888, 190.20.

82. *Table of products by vessel and shore fisheries.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Vessel fisheries:				
Bluefish	30,000	$1,350		
Cod	30,150	603	20,900	$418
Haddock	28,184	563	20,766	415
Mackerel			28,000	2,520
Mackerel, salted	150,000	9,000	124,000	7,861
Menhaden	2,794,800	4,675	7,611,200	15,359
Perch			7,000	563
Sea bass	665,750	22,750	738,505	35,302
Striped bass			40,000	2,400
Oysters	1,565,879	183,168	1,592,171	165,339
Total	5,264,763	222,109	10,182,542	230,177
Shore fisheries:				
Alewives	452,085	4,910	536,157	5,635
Alewives, salted	89,400	2,180	117,000	2,730
Black bass	7,280	728	7,680	768
Carp	5,200	260	5,500	275
Catfish	224,452	10,262	226,756	10,349
Eels	209,285	9,134	213,185	9,300
Perch	10,600	530	11,200	560
Shad	1,423,952	76,175	1,387,200	76,942
Sturgeon	61,250	700	63,000	720
Striped bass	14,400	1,440	19,100	1,910
Suckers and mullet	130,067	4,428	129,150	4,418
Wall-eyed pike	2,000	200	2,200	220
Total	2,629,971	110,947	2,718,128	113,827

82. *Table of products by vessel and shore fisheries*—Continued.

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Total vessel and shore fisheries:				
Alewives	452, 085	$4, 910	536, 157	$5, 635
Alewives, salted	89, 400	2, 180	117, 000	2, 730
Black bass	7, 280	728	7, 680	768
Bluefish	30, 000	1, 350	....	....
Carp	5, 200	260	5, 500	275
Catfish	224, 452	10, 262	226, 756	10, 349
Cod	30, 150	603	20, 900	418
Eels	209, 285	9, 134	213, 185	9, 300
Haddock	28, 184	563	20, 766	415
Mackerel	....	....	28, 000	2, 520
Mackerel, salted	150, 000	9, 000	124, 000	7, 861
Menhaden	2, 794, 800	4, 675	7, 611, 200	15, 359
Perch	10, 600	530	18, 200	1, 123
Sea bass	665, 750	22, 750	738, 505	35, 302
Shad	1, 423, 952	76, 175	1, 387, 200	76, 942
Sturgeon	61, 250	700	63, 000	720
Striped bass	14, 400	1, 440	59, 100	4, 310
Suckers and mullet	130, 067	4, 428	129, 150	4, 418
Wall-eyed pike	2, 000	200	2, 200	220
Oysters	1, 565, 879	183, 168	1, 592, 171	165, 339
Total	7, 894, 734	333, 056	12, 900, 670	344, 004

83. *Table showing by apparatus and species the yield of the shore fisheries of Pennsylvania in* 1887 *and* 1888.

1887.

Species.	Gill nets.		Seines.		Fyke nets.		Lines.		Pots, dip nets, and traps.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	218, 335	$2, 710	233, 750	$2, 200							452, 085	$4, 910
Alewives, salted			89, 400	2, 180							89, 400	2, 180
Black bass							7, 280	$728			7, 280	728
Catfish	1, 600	80	86, 520	4, 326	112, 720	$4, 964	23, 612	892			224, 452	10, 262
Carp									5, 200	$260	5, 200	260
Eels					21, 605	1, 328	12, 680	806	175, 000	7, 000	209, 285	9, 134
Perch			10, 000	500			600	30			10, 600	530
Shad	1, 058, 020	56, 102	365, 932	20, 073							1, 423, 952	76, 175
Striped bass			11, 900	1, 190			2, 500	250			14, 400	1, 440
Sturgeon	61, 250	700									61, 250	700
Suckers			85, 000	3, 400	32, 067	768			13, 000	260	130, 067	4, 428
Wall-eyed pike							2, 000	200			2, 000	200
Total	1, 339, 205	59, 592	882, 502	33, 869	166, 392	7, 060	48, 672	2, 906	193, 200	7, 520	2, 629, 971	110, 947

1888.

Species.	Gill nets.		Seines.		Fyke nets.		Lines.		Pots, dip nets, and traps.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	227, 407	$2, 835	308, 750	$2, 800							536, 157	$5, 635
Alewives, salted			117, 000	2, 730							117, 000	2, 730
Black bass							7, 680	$768			7, 680	768
Catfish	400	20	88, 000	4, 400	112, 240	$4, 935	26, 116	994			226, 756	10, 349
Carp									5, 500	$275	5, 500	275
Eels					23, 605	1, 428	12, 080	772	177, 500	7, 100	213, 185	9, 300
Perch			10, 300	515			900	45			11, 200	560
Shad	1, 027, 608	54, 656	359, 592	22, 286							1, 387, 200	76, 942
Striped bass			16, 500	1, 650			2, 600	260			19, 100	1, 910
Sturgeon	63, 000	720									63, 000	720
Suckers			83, 750	3, 350	32, 400	808			13, 000	260	129, 150	4, 418
Wall-eyed pike							2, 200	220			2, 200	220
Total	1, 318, 415	58, 231	983, 892	37, 731	168, 245	7, 171	51, 576	3, 059	196, 000	7, 635	2, 718, 128	113, 827

DELAWARE.

All the commercial fisheries of this State are included in the tables. There has been little or no change in the general fisheries of Delaware since the census year, except in the oyster industry, in which there has been a remarkable decline, all the more noticeable because of the increase in this fishery in New Jersey, on the opposite side of Delaware Bay.* The oyster yield in 1888 was 41,855 bushels; in 1880 it was 300,000 bushels, or about seven times as large.

A limited menhaden industry has been developed in recent years; two factories have been built by Connecticut capitalists at Lewes; these have been supplied by four or five fishing steamers hailing from Connecticut ports; their catch has necessarily been credited to the localities where they are owned. The shore industry and the output of the factory are assigned to Delaware, where they properly belong.

84. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	76	97
On transporting vessels	53	48
On boats	1,847	1,818
On shore—in factories, etc	131	131
Total	2,107	2,094

85. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	Number.	Value.	Number.	Value.
Vessels fishing *	22	$24,025	26	$25,100
Outfit		1,117		1,687
Vessels transporting †	17	26,800	17	19,450
Outfit		645		590
Boats	1,021	38,495	1,019	38,800
Apparatus of capture—vessel fisheries:				
Seines	1	20		
Dredges and tongs	107	2,059	142	2,773
Lines	8	4		
Apparatus of capture—shore fisheries:				
Seines	229	12,254	229	12,101
Gill nets	1,429	46,140	1,454	46,101
Pound nets	10	750	11	750
Fyke nets	698	1,813	720	1,864
Lobster and eel pots	1,237	1,129	1,167	1,056
Cast nets, hoop nets, and dip nets	76	221	77	228
Crabbing and terrapin outfits	215	113	217	112
Tongs and rakes	145	685	146	694
Lines		88		99
Miscellaneous apparatus	58	113	61	119
Shore property, factories, etc		49,790		49,980
Cash capital		40,500		30,500
Total capital		246,761		232,004

* Tonnage in 1887, 258.44; in 1888, 321.84. † Tonnage in 1887, 446.35; in 1888, 315.29.

*The difference in the results of the oyster fishery in the two States is ascribed to the varying methods of conducting the industry. In Delaware the fishermen have depended chiefly upon the crops from the natural beds, while in New Jersey a large amount of artificial planting is done each season.

86. *Table of products.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Fish.				
Alewives	1,149,955	$12,598	941,986	$10,925
Catfish	91,219	5,804	92,406	5,877
Croakers	121,972	4,792	97,887	3,728
Eels	436,506	22,887	432,613	23,160
Flounders	27,455	989	22,930	805
Kingfish	17,750	888	22,400	1,120
Menhaden	227,902	1,588	224,765	1,598
Mullet	17,025	440	16,760	438
Perch	256,798	15,364	242,868	14,917
Pike	26,268	2,073	25,389	2,031
Sea bass	4,400	192	1,560	78
Shad	1,270,492	47,629	1,389,216	51,999
Squeteague	2,377,299	15,908	2,451,731	16,472
Striped bass	116,061	12,048	116,433	11,789
Sturgeon	2,824,650	25,051	2,800,350	28,132
Suckers	5,110	306	5,050	296
Miscellaneous*	3,195	110	3,017	91
Shellfish, crustaceans, etc.				
Clams	12,500	2,139	12,820	2,209
Crabs, hard-shell	7,766	123	7,033	111
Crabs, horse-shoe	864,000	864	816,000	816
Crabs, soft-shell	197,802	18,034	144,560	11,343
Lobsters	39,000	910	39,000	910
Maninoses	350	31	350	31
Oysters	275,100	17,526	292,985	17,920
Shrimp	900	450	920	460
Terrapin	20,484	2,037	20,577	1,972
Turtle	4,100	318	4,335	325
Total	10,396,059	211,099	10,225,941	209,553

* Includes bluefish, sheepshead, carp, sunfish, bitterheads, etc.

87. *Table of secondary products.*

Designation.	1887.		1888.	
	Quantity.	Value.	Quantity.	Value.
Caviare ....pounds..	178,000	$18,512	183,000	$26,352
Oil ....gallons..	232,300	61,829	153,870	48,572
Fertilizer ....tons..	3,000	57,030	1,820	30,700
Total	....	137,371	....	105,624

88. *Table showing by species the products of the vessel fisheries of Delaware.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Perch	200	$12	....	....
Sea bass	8,500	340	....	....
Striped bass	200	12	....	....
Oysters	210,245	23,187	286,363	$28,233
Total	219,145	23,551	286,363	28,233

89. *Table showing by apparatus and species the yield of the shore fisheries of Delaware in 1887, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Gill nets.		Haul seines.		Pound nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	721, 373	$6, 556	424, 442	$5, 983		
Catfish	3, 050	160	19, 500	1, 194	3, 200	$320
Croakers	84, 950	3, 816	45, 022	976		
Eels			47, 780	4, 019	300	15
Flounders			26, 875	955		
Kingfish	17, 750	888				
Menhaden	162, 219	1, 128	58, 180	231		
Mullet	13, 825	327	9, 333	311		
Perch	121, 881	8, 085	118, 406	6, 512	5, 713	208
Pike	20, 487	1, 667	4, 831	330		
Shad	1, 103 744	42, 850	153, 868	4, 431		
Squeteague	43, 752	1, 976	2, 309, 047	13, 302		
Striped bass	45, 400	5, 967	62, 341	5, 054	4, 867	664
Sturgeon	2, 824, 650	25, 051				
Suckers	1, 200	86	3, 910	220		
Miscellaneous*			2, 500	50	215	11
Total	5, 164, 281	98, 557	3, 286, 035	43, 568	14, 295	1, 218

Species.	Fyke nets.		Pots.		Spears.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	740	$19				
Catfish	36, 618	2, 370				
Eels	9, 432	482	129, 144	$8, 077	244, 850	$9, 794
Mullet	1, 070	26				
Perch	10, 498	553				
Pike	950	76				
Sea bass	1, 400	42				
Shad	2, 000	70				
Striped bass	950	106				
Total	63, 658	3, 744	129, 144	8, 077	244, 850	9, 794

Species.	Lines.		Minor forms of apparatus.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives			3, 600	$100	1, 150, 155	$12, 658
Catfish	8, 322	$540	20, 528	1, 220	91, 218	5, 804
Croakers					129, 972	4, 792
Eels	5, 000	500			436, 506	22, 887
Flounders			580	34	27, 455	989
Kingfish					17, 750	888
Menhaden					220, 399	1, 359
Mullet			300	5	24, 528	669
Perch			300	6	256, 798	15, 364
Pike					26, 268	2, 073
Sea bass	3, 000	150			4, 400	192
Shad			10, 880	278	1, 270, 492	47, 629
Squeteague	24, 500	630			2, 377, 299	15, 908
Striped bass	2, 383	286	100	10	116, 041	12, 087
Sturgeon					2, 824, 650	25, 051
Suckers					5, 110	306
Miscellaneous*	500	50			3, 215	111
Total	43, 705	2, 156	36, 288	1, 653	8, 982, 256	168, 767

* Includes bluefish, sunfish, black bass, sheepshead, carp, and other minor species.

90. *Table showing by apparatus and species the yield of the shore fisheries of Delaware in 1888, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Gill nets.		Haul seines.		Pound nets.		Fyke nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	549, 872	$5, 295	389, 669	$5, 530			745	$20
Catfish	3, 050	160	15, 160	982	3, 000	$300	38, 602	2, 490
Croakers	65, 453	2, 878	32, 434	850				
Eels			50, 830	4, 253			10, 250	500
Flounders	930	50	20, 000	715			2, 000	40
Kingfish	22, 400	1, 120						
Menhaden	157, 395	1, 093	59, 500	245				
Mullet	12, 860	316	10, 550	355			600	18
Perch	111, 050	7, 630	122, 478	6, 756	1, 850	136	7, 190	389
Pike	20, 194	1, 667	4, 345	296			850	68
Shad	1, 217, 072	46, 444	169, 984	5, 116			2, 480	86
Squeteague	26, 492	1, 274	2, 410, 139	14, 736				
Striped bass	43, 574	5, 731	64, 983	5, 162	5, 000	560	375	39
Sturgeon	2, 800, 350	28, 132						
Suckers	1, 200	86	3, 850	210				
Miscellaneous*			2, 518	51	217	11		
Total	5, 031, 892	101, 876	3, 356, 440	45, 257	10, 067	1, 007	63, 092	3, 650

Species.	Pots.		Spears.		Lines.		Minor forms of apparatus.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives							2, 500	$80	942, 786	$10, 925
Catfish					8, 422	$520	24, 172	1, 425	92, 406	5, 877
Croakers									97, 887	3, 728
Eels	114, 633	$7, 819	251, 700	$10, 068	5, 200	520			432, 613	23, 160
Flounders									22, 930	805
Kingfish									22, 400	1, 120
Menhaden									216, 895	1, 338
Mullet							620	9	24, 630	698
Perch							300	6	242, 868	14, 917
Pike									25, 389	2, 031
Sea bass					1, 560	78			1, 560	78
Shad							12, 080	303	1, 401, 616	51, 949
Squeteague					15, 100	442			2, 451, 731	16, 452
Striped bass					2, 383	286	100	10	116, 415	11, 788
Sturgeon									2, 800, 350	28, 132
Suckers									5, 050	296
Miscellaneous*					300	30			3, 035	92
Total	114, 633	7, 819	251, 700	10, 068	32, 965	1, 876	39, 772	1, 833	8, 900, 561	173, 386

*Includes bluefish, sunfish, black bass, sheepshead, carp, and other minor species.

91. *Table showing the extent of the menhaden industry of Delaware.*

Designation.	1887.	1888.
Number of factories in operation	2	2
Value of factories	$43, 300	$13, 500
Amount of cash capital	$40, 000	$30, 000
Number of shoresmen employed	88	88
Number of fishermen employed	107	84
Number of steam vessels employed	5	4
Net tonnage	368. 11	305. 57
Value	$49, 000	$41, 000
Value of outfit	$8, 400	$6, 900
Number of menhaden handled	34, 460, 000	24, 000, 000
Value to fishermen	$46, 521	$32, 940
Number of gallons of oil made	232, 300	153, 870
Value as sold	$61, 829	$48, 572
Number of tons of scrap produced	3, 000	1, 800
Value as sold	$57, 030	$30, 700

MARYLAND.

All of the commercial fisheries of the State, with the exception of those of the Potomac River, are included in these tables. Reliable figures show 777 persons to have been engaged in the fisheries of this omitted region in 1888. They had boats and apparatus valued at $70,890, and took products to the value of $320,243, chiefly oysters and anadromous fish. These items do not enter into the tables.

Maryland now, as in 1880, leads all other States in number of persons employed, showing an increase since that year of more than 5,000. It is next to Massachusetts in capital invested, and the fishing fleet is much larger than that of any other State; but owing to the decadence in the oyster industry, the most important fishery in the State, the value of its products shows a considerable decline. In some fisheries there has been a gratifying increase, and in a few cases a remarkable advance. One very striking instance of this kind is the pound-net fishery. In 1880 there were reported only 83 pound nets, but in 1888 there were 599 in operation, not including the Potomac River, where there were over 100 more. There has been a large advance in the yield of shad, nearly 2,000,000 pounds more being taken in 1888 than in 1880. Nevertheless, the State has lost rank in this branch; in 1880 it headed the list, but now holds only fourth place.

92. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	8,353	8,407
On transporting vessels	1,118	1,042
On fishing boats	13,825	14,195
On transporting boats	49	51
On shore	8,104	8,256
Total	31,449	31,951

93. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	Number.	Value.	Number.	Value.
Vessels fishing*	1,310	$1,121,620	1,309	$1,012,785
Outfit		316,664		325,495
Vessels transporting†	327	518,970	309	423,580
Outfit		17,065		15,230
Boats fishing	7,517	368,042	7,751	386,039
Boats transporting	26	6,050	27	6,200
Apparatus of capture—vessel fisheries:				
Dredges, tongs, etc	3,142	84,538	3,179	86,387
Seines	21	10,500	24	12,200
Hand lines	51	17	48	15
Apparatus of capture—shore fisheries:				
Dredges, tongs, rakes, etc	10,095	52,864	10,469	54,953
Pound nets	391	36,045	430	38,755
Stake weirs	179	2,210	169	2,095
Haul seines	425	50,105	455	53,700
Fyke nets	7,333	29,052	7,833	30,887
Gill nets	7,089	42,098	7,460	44,494
Trammel nets	36	2,625	39	2,775
Eel pots	2,995	2,735	3,569	3,216
Hand lines, trawl lines, trot lines, etc		1,828		1,783
Miscellaneous nets and minor apparatus	3,440	5,228	3,789	5,228
Shore property		1,723,826		1,753,659
Cash capital		1,950,974		2,029,493
Total		6,343,056		6,288,969

*Tonnage in 1887, 23,659.10; in 1888, 23,242.98. †Tonnage in 1887, 10,569.52; in 1888, 10,213.46.

94. *Table of products by vessel and shore fisheries.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Vessel fisheries:				
Bluefish	1,000	$10	1,200	$45
Menhaden	22,448,400	43,639	24,473,280	52,678
Sea bass	185,000	7,000	150,672	6,170
Spanish mackerel	475	95	500	100
Oysters	28,475,251	1,487,400	31,350,669	1,666,545
Total	51,110,126	1,538,174	55,976,321	1,725,538
Shore fisheries:				
Alewives	9,405,170	64,336	8,938,374	67,501
Alewives, salted	1,644,600	24,772	2,548,400	42,440
Alewives, smoked	12,500	165	25,000	350
Bluefish	382,259	17,911	574,743	27,249
Catfish	1,289,516	42,303	1,262,113	41,878
Eels	483,435	22,981	517,449	24,582
Flatfish and flounders	18,000	707	16,030	599
Menhaden	1,114,860	3,362	1,188,908	3,597
Menhaden, salted	44,600	776	49,600	861
Mullet and suckers	261,047	5,880	264,963	5,895
Perch, white	966,445	46,589	999,278	47,828
Perch, yellow	1,093,273	26,847	1,098,696	27,202
Pike	521,146	33,496	577,745	37,286
Sea bass	24,375	730	28,000	840
Shad	4,040,820	146,951	4,868,435	176,655
Sheepshead	9,605	662	9,899	677
Spanish mackerel	13,770	1,898	15,177	2,024
Spots and croakers	316,291	12,654	318,487	12,915
Squeteague	524,727	16,477	537,411	18,382
Squeteague, salted	3,400	133	7,800	288
Striped bass	1,139,950	96,873	1,123,004	96,856
Sturgeon	7,800	296	7,800	312
Sunfish	107,971	2,656	100,108	2,500
Miscellaneous fish	41,647	1,465	44,427	1,543
Clams (*Venus mercenaria*)	334,976	11,405	326,784	11,270
Oysters	28,562,268	1,196,035	28,370,937	1,211,245
Crabs, hard	2,757,638	36,969	2,674,675	37,438
Crabs, soft	1,636,530	133,788	2,208,829	161,331
Shrimp	8,050	3,880	8,050	3,880
Frogs	1,875	256	1,875	257
Terrapin	77,751	21,322	73,848	20,579
Turtle	25,555	1,433	24,947	1,401
Total	56,871,850	1,976,008	58,811,792	2,087,661
Total vessel and shore fisheries:				
Alewives	9,405,170	64,336	8,938,374	67,501
Alewives, salted	1,644,600	24,772	2,548,400	42,440
Alewives, smoked	12,500	165	25,000	350
Bluefish	383,259	17,951	575,943	27,294
Catfish	1,289,516	42,303	1,262,113	41,878
Eels	483,435	22,981	517,449	24,582
Flatfish and flounders	18,000	707	16,030	599
Menhaden	23,563,260	47,001	25,662,188	56,275
Menhaden, salted	44,600	776	49,600	861
Mullet and suckers	261,047	5,880	264,963	5,895
Perch, white	966,445	46,589	999,278	47,828
Perch, yellow	1,093,273	26,847	1,098,696	27,202
Pike	521,146	33,496	577,745	37,286
Sea bass	209,375	7,730	178,672	7,010
Shad	4,040,820	146,951	4,868,435	176,655
Sheepshead	9,605	662	9,899	677
Spanish mackerel	14,245	1,993	15,677	2,124
Spots and croakers	316,291	12,654	318,487	12,915
Squeteague	524,727	16,477	537,411	18,382
Squeteague, salted	3,400	133	7,800	288
Striped bass	1,139,950	96,873	1,123,004	96,856
Sturgeon	7,800	296	7,800	312
Sunfish	107,971	2,656	100,108	2,500
Miscellaneous fish	41,647	1,465	44,427	1,543
Clams (*Venus mercenaria*)	334,976	11,405	326,784	11,270
Oysters	57,037,519	2,683,435	59,721,606	2,877,790
Crabs, hard	2,757,638	36,969	2,674,675	37,438
Crabs, soft	1,636,530	133,788	2,208,829	161,331
Shrimp	8,050	3,880	8,050	3,880
Frogs	1,875	256	1,875	257
Terrapin	77,751	21,322	73,848	20,579
Turtle	25,555	1,433	24,947	1,401
Total	107,981,970	3,514,182	114,788,113	3,813,199

95. *Table showing by apparatus and species the yield of the shore fisheries of Maryland in 1887, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Haul seines.		Gill nets.		Trammel nets.		Pound nets.		Fyke nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	3,791,302	$26,978	977,240	$13,596	....	......	4,293,172	$21,196	72,256	$924
Alewives, salted	1,618,600	24,327	6,000	95	....	......	....	......	....	......
Bluefish	53,040	2,561	241,115	11,678	....	......	18,379	1,102	....	......
Catfish	315,832	10,701	36,532	893	1,720	$77	146,888	4,141	491,684	15,459
Eels	20,367	674	746	23	....	......	52,998	2,045	123,968	5,349
Flatfish and flounders	3,750	130	....	......	....	......	11,800	485	1,400	50
Menhaden	622,740	1,828	337,020	927	....	......	119,100	487	36,000	120
Menhaden, salted	42,600	746	....	......	....	......	....	......	2,000	30
Mullet and suckers	56,669	1,265	88,943	2,114	2,000	50	69,085	1,409	15,350	315
Perch, white	328,842	17,273	179,036	7,884	1,000	50	202,273	9,975	206,570	9,447
Perch, yellow	269,825	7,522	81,065	1,352	....	......	334,451	8,724	378,381	8,599
Pike	139,006	8,583	138,179	7,722	44,024	3,170	92,805	6,306	107,132	7,715
Sea bass	21,000	630	....	......	....	......	1,500	45	....	......
Shad	992,904	34,913	2,535,413	90,857	....	......	472,789	19,512	39,684	1,669
Spanish mackerel	....	......	13,770	1,898	....	......	....	......	....	......
Spots and croakers	86,071	3,969	9,585	373	....	......	16,575	710	1,000	48
Squeteague	54,320	2,070	46,887	1,949	....	......	7,775	410	2,800	112
Squeteague, salted	....	......	1,400	63	....	......	....	......	....	......
Striped bass	463,649	42,842	171,122	13,964	29,000	2,920	307,276	24,794	83,211	6,834
Sturgeon	....	......	7,800	296	....	......	....	......	....	......
Sunfish	54,211	1,368	3,333	100	3,300	100	11,667	350	35,460	738
Miscellaneous species	1,680	68	11,367	530	....	......	13,300	372	500	15
Total	8,936,408	188,448	4,886,583	156,314	81,044	6,367	6,171,833	102,063	1,597,396	57,424

Species.	Bow nets, scoop nets, and cast nets.		Pots.		Spears.		Lines.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	271,200	$1,642	....	......	....	......	....	......	9,405,170	$64,336
Alewives, salted	20,000	350	....	......	....	......	....	......	1,644,600	24,772
Alewives, smoked	12,500	165	....	......	....	......	....	......	12,500	165
Bluefish	....	......	....	......	....	......	69,725	$2,570	382,259	17,911
Catfish	7,600	190	....	......	....	......	289,260	10,842	1,289,516	42,303
Eels	....	......	252,539	$13,213	30,624	$1,609	2,193	68	483,435	22,981
Flatfish and flounders	....	......	....	......	....	......	1,050	42	18,000	707
Menhaden	....	......	....	......	....	......	....	......	1,114,860	3,362
Menhaden, salted	....	......	....	......	....	......	....	......	44,600	776
Mullet and suckers	23,200	580	....	......	....	......	5,800	147	261,047	5,880
Perch, white	28,930	1,140	....	......	....	......	19,794	820	966,445	46,589
Perch, yellow	26,096	595	....	......	....	......	3,455	55	1,093,273	26,847
Pike	....	......	....	......	....	......	....	......	521,146	33,496
Sea bass	....	......	....	......	....	......	1,875	55	24,375	730
Shad	....	......	....	......	....	......	....	......	4,040,820	146,951
Sheepshead	....	......	....	......	....	......	9,605	662	9,605	662
Spanish mackerel	....	......	....	......	....	......	....	......	13,770	1,898
Spots and croakers	....	......	....	......	....	......	203,060	7,554	316,291	12,654
Squeteague	....	......	....	......	....	......	412,945	11,936	524,727	16,477
Squeteague, salted	....	......	....	......	....	......	2,000	70	3,400	133
Striped bass	13,750	862	....	......	....	......	71,942	4,657	1,139,950	96,873
Sturgeon	....	......	....	......	....	......	....	......	7,800	296
Sunfish	....	......	....	......	....	......	....	......	107,971	2,656
Miscellaneous species	....	......	....	......	....	......	14,800	480	41,647	1,465
Total	403,276	5,524	252,539	13,213	30,624	1,609	1,107,504	39,958	23,467,207	570,920

96. *Table showing by apparatus and species the yield of the shore fisheries of Maryland in 1888, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Haul seines.		Gill nets.		Trammel nets.		Pound nets.		Fyke nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	3,845,782	$28,561	988,650	$13,989			3,751,386	$22,301	81,956	$1,016
Alewives, salted	2,522,400	41,995	6,000	95						
Bluefish	54,510	2,660	439,004	21,705			17,129	1,071		
Catfish	302,941	10,360	40,216	982	1,800	$81	142,028	4,136	507,168	16,494
Eels	12,601	531	746	23			67,810	2,677	133,965	5,706
Flatfish and flounders	2,375	85					10,880	469	1,525	55
Menhaden	598,948	1,746	349,500	1,032			204,460	699	36,000	120
Menhaden, salted	47,600	831							2,000	30
Mullet and suckers	57,543	1,265	78,575	1,857	2,000	50	80,135	1,628	17,510	360
Perch, white	352,823	18,098	199,935	8,872	1,000	50	192,884	9,183	206,379	9,717
Perch, yellow	258,107	6,974	83.153	1,421			341,620	9,029	387,395	9,159
Pike	154,493	9,159	151,325	8,537	56,024	3,930	101,316	6,939	114,587	8,721
Sea bass	24,000	720					2,500	75		
Shad	1,128,865	39,770	3,171,342	111,706			531,029	23,574	37,199	1,605
Spanish mackerel			15,177	2,024						
Spots and croakers	76,072	3,528	8,310	315			14,120	615	1,400	64
Squeteague	48,990	1,933	69,590	2,855			10,775	453	2,800	112
Squeteague, salted			1,400	63						
Striped bass	444,366	42,537	180,886	15,038	35,800	3,576	295,590	23,499	87,477	7,015
Sturgeon			7,350	312						
Sunfish	46,114	1,196	4,167	125	3,700	111	11,667	350	34,460	718
Miscellaneous species	2,760	121	11,367	530			15,800	422	500	15
Total	9,981,290	212,070	5,806,693	191,481	100,324	7,798	5,791,129	107,060	1,652,321	60,907

Species.	Bow, scoop, and cast nets.		Pots.		Spears.		Lines.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	270,600	$1,634							8,938,374	$67,501
Alewives, salted	20,000	350							2,548,400	42,440
Alewives, smoked	25,000	350							25,000	350
Bluefish							64,100	$1,813	574,743	27,249
Catfish	7,600	192					260,360	9,633	1,262,113	41,878
Eels			278,399	$14,378	22,068	$1,209	1,860	58	517,449	24,582
Flatfish and flounders							1,250	50	16,030	599
Menhaden									1,188,908	3,597
Menhaden, salted									49,600	861
Mullet and suckers	23,200	580					6,000	155	264,963	5,895
Perch, white	26,680	1,055					19,577	852	999,278	47,827
Perch, yellow	24,296	554					4,125	65	1,098,696	27,202
Pike									577,745	37,286
Sea bass							1,500	45	28,000	840
Shad									4,868,435	176,655
Sheepshead							9,899	677	9,899	677
Spanish mackerel									15,177	2,024
Spots and croakers							218,880	7,614	318,782	12,136
Squeteague							405,256	13,029	537,411	18,382
Squeteague, salted							6,400	225	7,800	288
Striped bass	12,450	792					66,435	4,399	1,123,004	96,856
Sturgeon									7,350	312
Sunfish									100,108	2,500
Miscellaneous species							14,000	455	44,427	1,543
Total	409,826	5,507	278,399	14,378	22,068	1,209	1,079,642	39,070	25,121,692	639,480

97. *Summary by customs districts of the vessel fisheries of Maryland.*

Designation.	Eastern.		Baltimore.		Annapolis.		Total.	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
Number and nationality of fishermen:								
Americans, white	1,607	1,617	2,934	3,356	166	196	4,707	5,169
Americans, colored	1,440	1,432	461	404	146	136	2,047	1,972
All others	1,093	1,157	495	109	11	......	1,599	1,266
Total	4,140	4,206	3,890	3,869	323	332	8,353	8,407
Number and nationality of crews on transports:								
Americans, white	311	247	418	401	76	74	805	722
Americans, colored	133	125	148	162	27	24	308	311
All others	4	8	1	1	......	......	5	9
Total	448	380	567	564	103	98	1,118	1,042
Number of vessels fishing	710	717	541	527	59	65	1,310	1,309
Number of vessels transporting	125	106	170	171	32	32	327	309
Net tonnage of vessels fishing	10,775.82	10,473.29	11,971.50	11,925.08	911.78	844.61	23,659.10	23,242.98
Net tonnage of vessels transporting	4,182.78	3,743.23	5,684.96	5,785.91	701.78	684.32	10,569.52	10,213.46
Value of vessels fishing	$591,325	$547,840	$488,195	$418,570	$42,100	$46,375	$1,121,620	$1,012,785
Value of vessels transporting	208,915	155,900	273,930	237,630	36,125	30,050	518,970	423,580
Value of outfit, gear, provisions, fuel, etc., of vessels fishing	203,764	216,720	192,855	194,290	15,100	13,087	411,719	424,097
Value of provisions, fuel, etc., of vessels transporting	6,720	4,765	8,545	8,600	1,800	1,865	17,065	15,230
Value of catch of vessels fishing	679,781	789,311	811,881	874,660	46,512	61,567	1,538,174	1,725,538
Value of products transported	514,743	477,166	725,950	590,901	88,600	95,331	1,329,293	1,163,398

98. *Table showing the extent of the menhaden industry of Maryland.*

Designation.	1887.	1888.
Number of factories in operation	3	3
Value of factories	$17,800	$27,800
Amount of cash capital	$28,500	$30,500
Number of shoresmen employed	48	55
Number of fishermen employed	81	71
Number of steam vessels employed	2	3
Net tonnage	136.26	198.80
Value	$14,000	$20,000
Value of outfit	$4,800	$5,600
Number of sailing vessels employed	3	2
Net tonnage	111.53	58.10
Value	$5,100	$3,300
Value of outfit	$3,500	$2,200
Number of vessels employed as "carryaways"	4	3
Net tonnage	94.35	63.10
Value	$4,800	$3,500
Value of outfit	$250	$200
Number of menhaden handled	12,210,000	18,974,050
Value to fishermen	$16,789	$21,345
Number of gallons of oil made	71,500	44,850
Value as sold	$16,115	$12,008
Number of tons of scrap produced	1,125	1,843
Value as sold	$18,900	$28,134

VIRGINIA.

The tables for this State include all commercial fisheries excepting those of the James and Potomac Rivers. Nearly complete data, however, have been obtained for these rivers and furnish a basis for the following estimates, which are in addition to any figures in the tabulated statements: In 1888 the fisheries of these rivers gave employment to 2,512 fishermen and $162,100 invested capital, and the value of products amounted to $555,610.

Considered as a whole, there has been a decline since 1880 in the fisheries of this State in the items of persons employed and value of catch, though the capital invested has increased. The decrease is almost entirely attributable to the falling off in the oyster industry. There has been a phenomenal increase in the pound-net fishery, particularly in the quantity of apparatus used. The catch of shad is much larger than formerly; Virginia now takes precedence of all other States in the shad fishery, though in 1880 it ranked third.

99. *Table of persons employed.*

How engaged.	1887.	1888.
On vessels fishing	3, 108	2, 969
On vessels transporting	882	940
On boats	5, 397	6, 545
On shore	2, 154	2, 161
Total	11, 541	12, 615

100. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing*	622	$476, 234	584	$432, 050
Outfit		135, 695		128, 949
Vessels transporting†	281	287, 750	310	307, 970
Outfit		22, 475		25, 030
Boats	3, 926	175, 225	4, 486	203, 793
Apparatus of capture—vessel fisheries:				
Purse seines	54	28, 800	48	26, 000
Haul seines	7	990	9	1, 110
Eel pots			40	30
Fyke nets			2	30
Dredges and tongs	3, 762	35, 741	3, 174	30, 704
Apparatus of capture—shore fisheries:				
Seines	130	13, 767	134	15, 497
Pound nets	608	164, 355	991	227, 015
Gill nets	1, 781	12, 014	1, 890	12, 465
Fyke nets	153	5, 305	177	6, 195
Tongs and rakes		18, 543		18, 390
Minor apparatus (lines, etc.)		1, 805		2, 464
Shore property, factories, etc		‡462, 957		‡464, 203
Cash capital		300, 300		306, 300
Total		2, 141, 956		2, 208, 225

* Tonnage in 1887, 9,088.01; in 1888, 8,522.43.
† Tonnage in 1887, 5,643.38; in 1888, 6,384.71.
‡ Not including $26,400 in 1887, and $33,700 in 1888, value of menhaden factories temporarily idle.

101. *Table of products by vessel and shore fisheries.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Vessel fisheries:				
Bluefish			56, 834	$2, 075
Menhaden	56, 930, 400	$113, 863	51, 374, 965	97, 274
Striped bass			1, 400	126
Spanish mackerel			8, 700	895
Clams	11, 856	734	2, 904	238
Oysters	9, 230, 709	456, 797	8, 435, 931	434, 064
Turtles			4, 400	92
Total	66, 172, 965	571, 394	59, 885, 134	534, 764
Shore fisheries:				
Alewives	3, 822, 635	18, 563	5, 844, 805	28 392
Alewives, salted	579, 000	11, 022	608, 200	11, 977
Bluefish	1, 126, 100	50, 364	1, 790, 110	86, 252
Bluefish, salted	80, 000	4, 000	132, 000	6, 600
Bonito (*Elacate*)	12, 500	400	31, 250	1, 000
Hickory shad	174, 438	3, 424	206, 783	3, 993
Menhaden	4, 638, 850	11, 777	7, 471, 048	16, 441
Menhaden, salted	22, 200	600	18, 200	485
Mullet	99, 600	1, 990	102, 600	2, 143
Sea bass	9, 667	282	9, 800	294
Shad	3, 815, 126	172, 272	7, 056, 473	321, 634
Sheepshead	10, 190	488	12, 195	588
Striped bass	505, 454	32, 758	777, 906	49, 971
Spanish mackerel	108, 000	10, 240	231, 252	20, 184
Spots	1, 270, 809	33, 419	1, 502, 524	39, 436
Spots, salted	180, 000	9, 000	200, 000	10, 000
Squeteague	1, 099, 548	50, 660	1, 103, 678	53, 514
Squeteague, salted	4, 950	200	5, 175	210
Miscellaneous	1, 144, 722	8, 982	1, 280, 415	13, 412
Clams	745, 304	36, 063	769, 896	37, 468
Crabs	626, 820	15, 479	956, 843	24, 669
Oysters	11, 217, 268	546, 104	11, 145, 050	555, 148
Terrapin	140, 256	16, 800	143, 777	16, 965
Turtles	29, 000	530	33, 700	615
Total	31, 462, 437	1, 035, 417	41, 433, 680	1, 301, 391
Total vessel and shore fisheries:				
Alewives	3, 822, 635	18, 563	5, 844, 805	28, 392
Alewives, salted	579, 000	11, 022	608, 200	11, 977
Bluefish	1, 126, 100	50, 364	1, 846, 944	88, 327
Bluefish, salted	80, 000	4, 000	132, 000	6, 600
Bonito	12, 500	400	31, 250	1, 000
Hickory shad	174, 438	3, 424	206, 783	3, 993
Menhaden	61, 569, 250	125, 640	58, 846, 013	113, 715
Menhaden, salted	22, 200	600	18, 200	485
Mullet	99, 600	1, 990	102, 600	2, 143
Sea bass	9, 667	282	9, 800	294
Shad	3, 815, 126	172, 272	7, 056, 473	321, 634
Sheepshead	10, 190	488	12, 195	588
Striped bass	505, 454	32, 758	779, 306	50, 097
Spanish mackerel	108, 000	10, 240	239, 952	21, 079
Spots	1, 270, 809	33, 419	1, 502, 524	39, 436
Spots, salted	180, 000	9, 000	200, 000	10, 000
Squeteague	1, 099, 548	50, 660	1, 103, 678	53, 514
Squeteague, salted	4, 950	200	5, 175	210
Miscellaneous	1, 144, 722	8, 982	1, 280, 415	13, 412
Clams	757, 160	36, 797	772, 800	37, 706
Crabs	626, 820	15, 479	956, 843	24, 669
Oysters	20, 447, 977	1, 002, 901	19, 580, 981	989, 212
Terrapin	140, 256	16, 800	143, 777	16, 965
Turtles	29, 000	530	38, 100	707
Total	97, 635, 402	1, 606, 811	101, 318, 814	1, 836, 155

102. *Summary by customs districts of the vessel fisheries of Virginia in* 1887 *and* 1888

Customs districts.	No. of vessels fishing.		Net tonnage.		Value of vessels.		Value of outfit, gear, provisions, fuel, etc.		Number and nationality of fishermen.								Value of catch.	
									1887.				1888.					
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	Amer., white.	Amer., colored.	All others.	Total.	Amer., white.	Amer., colored.	All others.	Total.	1887.	1888.
Cherrystone	174	181	2, 728. 95	2, 921. 32	$152, 012	$171, 530	$63, 230	$71, 778	801	237	....	1, 038	862	314	4	1, 180	$170, 834	$197, 103
Alexandria	7	7	78. 49	78. 41	3, 750	3, 675	3, 425	3, 350	34	6	....	40	35	6	....	41	4, 295	5, 385
Tappahannock	72	65	1, 603. 12	1, 388. 89	89, 210	74, 100	43, 986	37, 256	315	212	4	531	252	208	....	460	116, 613	103. 284
Yorktown	140	121	2, 084. 04	1, 700. 40	102, 100	73, 995	37, 401	31, 460	318	272	7	597	262	266	....	528	110, 383	77, 456
Norfolk and Portsmouth	203	183	1, 852. 39	1, 706. 04	102, 662	84, 650	43, 702	36, 504	203	592	....	795	162	513	1	676	145, 885	130, 798
Petersburgh	3	2	28. 52	16. 76	1, 200	1, 200	376	375	1	7	....	8	2	6	....	8	1, 505	1, 310
Richmond	23	25	712. 50	710. 61	25, 300	22, 900	5, 542	4, 408	54	45	....	99	42	34	....	76	26, 174	24, 721
Total	622	584	9, 088. 01	8, 522. 43	476, 234	432, 050	197. 662	185, 131	1, 726	1, 371	11	3, 108	1, 617	1, 347	5	2, 969	575, 689	540, 057
Customs districts.	**No. of vessels transporting.**		**Net tonnage.**		**Value of vessels.**		**Value of provisions, fuel, etc.**		**Number and nationality of crew.**								**Value of products transported.**	
									1887.				1888.					
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.	Amer., white.	Amer., colored.	All others.	Total.	Amer., white.	Amer., colored.	All others.	Total.	1887.	1888.
Cherrystone	102	116	1, 907. 10	2, 086. 97	$113, 025	$112, 100	$9, 959	$10, 350	255	56	....	311	275	63	....	338	$189, 926	$215, 842
Alexandria	31	43	518. 37	926. 67	20, 850	46, 625	2, 600	3, 455	68	9	....	77	101	14	....	115	82, 680	102, 100
Tappahannock	42	41	1, 156. 55	1, 206. 81	43, 650	46, 350	3, 053	3, 030	71	58	....	129	69	62	....	131	140, 940	132, 212
Yorktown	74	71	1, 397. 44	1, 540. 28	78, 675	72, 420	6, 644	6, 130	136	104	....	240	148	76	....	224	360, 080	489, 349
Norfolk and Portsmouth	29	35	552. 54	510. 34	27, 550	27, 275	3, 419	3, 352	46	69	....	115	53	67	....	120	85, 708	72, 550
Petersburgh*	......	......	....	.....	....	....	....	....	....	....	....	....	....	....	....	....	233	....
Richmond	3	4	111. 38	113. 64	4, 000	3, 200	346	435	4	6	....	10	7	5	....	12	3, 364	1, 793
Total	281	310	5, 643. 38	6, 384. 71	287, 750	307, 970	26, 021	26, 752	580	302	....	882	653	287	....	940	862, 931	1, 013, 846

*Although no vessels of this district are exclusively engaged in transporting, one vessel in 1887 transported a small amount of products in addition to her catch.

103. *Table showing by apparatus and species the yield of the shore fisheries of Virginia in 1887, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Seines.		Gill nets.		Pound nets.		Fyke nets.		Lines and minor apparatus.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives	49,600	$248	128,000	$568	3,645,035	$17,747				
Alewives, salted					579,000	11,022				
Bluefish	374,600	15,514	90,700	4,650	657,350	30,054			3,450	$146
Bluefish, salted			80,000	4,000						
Bonito					12,500	400				
Hickory shad	9,000	180			165,438	3,244				
Menhaden	105,500	1,030	116,850	2,037	4,416,500	8,710				
Menhaden, salted			22,200	600						
Mullet	51,900	1,032	16,000	340	12,800	236			18,900	382
Shad	57,165	2,167	187,810	8,510	3,560,431	161,095	9,720	$500		
Spots	551,961	14,039	586,800	15,130	108,208	3,190			23,840	1,060
Spots, salted	180,000	9,000								
Striped bass	18,307	1,396	14,360	1,010	410,700	25,742	58,036	4,250	4,051	360
Spanish mackerel	7,500	600	11,000	1,100	89,500	8,540				
Sheepshead					7,990	400			2,200	88
Sea bass	800	16							8,867	266
Squeteague	755,980	32,758	66,205	4,055	177,916	9,693	10,200	506	89,247	3,648
Squeteague, salted	2,700	120							2,250	80
Miscellaneous*	163,302	2,255	6,000	710	952,010	4,790	13,400	579	10,010	648
Total	2,328,315	80,355	1,325,925	42,710	14,795,378	276,763	91,356	5,835	162,815	6,678

SUMMARY.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Alewives	3,822,635	$18,563	Spots, salted	180,000	$9,000
Alewives, salted	579,000	11,022	Striped bass	505,454	32,758
Bluefish	1,126,100	50,364	Spanish mackerel	108,000	10,240
Bluefish, salted	80,000	4,000	Sheepshead	10,190	488
Bonito	12,500	400	Sea bass	9,667	282
Hickory shad	174,438	3,424	Squeteague	1,099,548	50,660
Menhaden	4,638,850	11,777	Squeteague, salted	4,950	200
Menhaden, salted	22,200	600	Miscellaneous*	1,144,722	8,982
Mullet	99,600	1,990			
Shad	3,815,126	172,272	Total	18,703,789	420,441
Spots	1,270,809	33,419			

* Includes eels, catfish, sunfish, sturgeon, kingfish, flounders, perch, hogfish, scup, drum, croakers, and other minor species.

104. *Table showing by apparatus and species the yield of the shore fisheries of Virginia in 1888, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Seines.		Gill nets.		Pound nets.		Fyke nets.		Lines and minor apparatus.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	62,400	$312	135,200	$601	5,647,205	$27,479				
Alewives, salted					608,200	11,977				
Bluefish	416,200	20,810	121,900	5,680	1,246,760	59,526			5,250	$236
Bluefish, salted			132,000	6,600						
Bonito					31,250	1,000				
Hickory shad	7,200	144			199,583	3,849				
Menhaden	80,525	990	87,600	1,352	7,302,923	14,099				
Menhaden, salted			18,200	485						
Mullet (*Mugil*)	53,100	1,098	15,700	380	14,900	283			18,900	382
Shad	67,277	2,600	242,550	11,240	6,734,588	307,194	12,058	$600		
Spots	544,891	14,066	749,300	19,196	181,493	4,994			26,840	1,180
Spots, salted	200,000	10,000								
Striped bass	24,513	1,786	17,950	1,267	675,860	42,099	54,067	4,267	5,516	552
Spanish mackerel	10,000	1,000	17,250	1,550	204,002	17,634				
Sheepshead					9,995	500			2,200	88
Sea bass	875	20							8,925	274
Squeteague	646,797	28,974	75,260	4,692	278,674	15,519	13,700	681	89,247	3,648
Squeteague, salted	2,750	122							2,425	88
Miscellaneous*	101,167	2,743	7,850	875	1,145,898	8,461	15,400	679	10,100	654
Total	2,217,695	84,665	1,620,760	53,918	24,281,331	514,614	95,225	6,227	169,403	7,102

104. *Table showing by apparatus and species the yield of the shore fisheries of Virginia in 1888, exclusive of the shellfish, crustacean, and reptilian fisheries*—Continued.

SUMMARY.

Species.	Pounds.	Value.	Species.	Pounds.	Value
Alewives	5,844,805	$28,392	Spots	1,502,524	$39,436
Alewives, salted	608,200	11,977	Spots, salted	200,000	10,000
Bluefish	1,790,110	86,252	Striped bass	777,906	49,971
Bluefish, salted	132,000	6,600	Spanish mackerel	231,252	20,184
Bonito	31,250	1,000	Sheepshead	12,195	588
Hickory shad	206,783	3,993	Sea bass	9,800	294
Menhaden	7,471,048	16,441	Squeteague	1,103,678	53,514
Menhaden, salted	18,200	485	Squeteague, salted	5,175	210
Mullet (*Mugil*)	102,600	2,143	Miscellaneous*	1,280,415	13,412
Shad	7,056,473	321,634			
			Total	28,384,414	666,526

*Includes eels, catfish, sunfish, sturgeon, kingfish, flounders, perch, hogfish, scup, drum, croakers, and other minor species.

105.—*Table showing the extent of the menhaden industry of Virginia.*

Designation.	1887.	1888.
Number of factories in operation	26	19
Value of factories	$170,950	$161,150
Amount of cash capital	$205,300	$182,300
Number of shoresmen employed	437	345
Number of fishermen employed	778	644
Number of steam vessels employed	10	11
Net tonnage	423.14	505.35
Value	$48,800	$64,000
Value of outfit	$19 900	$20,600
Number of sailing vessels employed in fishing	54	40
Net tonnage	1,691.05	1,263.00
Value	$80,750	$52,850
Value of outfit	$57,950	$39,350
Number of sailing vessels employed as "carryaways"	31	20
Net tonnage	964.61	717.49
Value	$45,050	$31,150
Value of outfit	$2,400	$2,000
Number of menhaden handled	128,415,000	103,099,300
Value to fishermen	$175,928	$115,471
Number of gallons of oil made	759,187	249,241
Value as sold	$138,414	$65,893
Number of tons of scrap produced	9,594	7,938
Value as sold	$191,991	$155,394

THE OYSTER FISHERY OF VIRGINIA, 1888.

The tables presented under this head are somewhat more detailed than have been given elsewhere for this fishery. They were originally prepared for a special purpose connected with contemplated changes in the oyster laws of the State; and, aside from the fact that the itemized figures were thus already available for incorporation in this review, it is thought that the importance of the subject warrants the introduction of such detailed statistics. The products will be found to differ somewhat from the preceding tables for the reason that in this case the entire oyster interests of the State are shown, while, as already explained, the regular tables omit consideration of the important boat oyster fishery in the James and Potomac Rivers. The following tabulations enter into the comparative statements which appear elsewhere.

106. *Table of persons employed.*

How engaged.	Number.
Vessel fisheries	2, 637
Boat fisheries	4, 222
Transporting and transplanting only	920
Packing houses, etc	1, 668
Total	9, 447

107. *Table of apparatus and capital.*

Designation.	Number.	Value.
Fishing vessels	554	$349, 700
Outfit		130, 467
Transporting and planting vessels	302	303, 145
Outfit		26, 370
Boats, exclusive of those on vessels	3, 961	126, 200
Dredges	419	13, 300
Tongs, rakes, etc	8, 831	48, 644
Shore property*		81, 600
Cash capital*		88, 000
Total investment		1, 167, 426

* Not including the oyster-packing industry.

108. *Table of products.*

How taken.	Bushels.	Value.
By vessels	1, 206, 033	$434, 364
By boats	2, 458, 400	901, 648
Total	3, 664, 433	1, 336, 012

109. *Table showing by customs districts the number, tonnage, and value of vessels engaged in dredging, tonging, and transporting and planting oysters.*

Customs districts.	Number of vessels.				Tonnage.			
	Dredging.	Tonging.	Transporting and planting.	Total.	Dredging.	Tonging.	Transporting and planting.	Total.
Cherrystone	163	9	116	288	2, 445. 68	102. 86	1, 907. 10	4, 455. 64
Alexandria		1	39	40		6. 60	880. 11	886. 71
Tappahannock	46	8	37	91	943. 16	67. 85	1, 154. 50	2, 165. 51
Yorktown	5	112	71	188	69. 91	1, 544. 89	1, 540. 28	3, 155. 08
Norfolk		183	35	218		1, 706. 04	510. 34	2, 216. 38
Petersburgh		2		2		16. 76		16. 76
Richmond		25	4	29		712. 50	113. 64	826. 14
Total	214	340	302	856	3, 458. 75	4, 157. 50	6, 105. 97	13, 722. 22

Customs districts.	Value of vessels.				Value of apparatus and outfit.			
	Dredging.	Tonging.	Transporting and planting.	Total.	Dredging.	Tonging.	Transporting and planting.	Total.
Cherrystone	$120, 010	$4, 720	$112, 100	$236, 830	$69, 258	$720	$10, 350	$80, 328
Alexandria		200	44, 500	44, 700		250	3, 180	3, 430
Tappahannock	42, 450	3, 650	43, 650	89, 750	22, 291	815	2, 923	26, 029
Yorktown	3, 500	66, 420	72, 420	142, 340	790	25, 810	6, 130	32, 730
Norfolk		84, 650	27, 275	111, 925		36, 504	3, 352	39, 856
Petersburgh		1, 200		1, 200		375		375
Richmond		22, 900	3, 200	26, 100		4, 408	435	4, 843
Total	165, 960	183, 740	303, 145	652, 845	92, 339	68, 882	26, 370	187, 591

110. *Table showing by customs districts the number of white and colored persons employed in different capacities in the vessel fishery for oysters.*

Customs districts.	Dredging.		Tonging.		Transporting and transplanting.		Total.		
	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.	Total.
Cherrystone	741	306	20	3	275	63	1,036	372	1,408
Alexandria				6	92	12	92	18	110
Tappahannock	151	148	11	13	62	60	224	221	445
Yorktown	9	8	217	244	148	76	374	328	702
Norfolk			163	513	53	67	216	580	796
Petersburgh			2	6			2	6	8
Richmond			42	34	7	5	49	39	88
Total	901	462	455	819	637	283	1,993	1,564	3,557

111. *Table showing by customs districts and apparatus of capture the yield of the vessel fishery for oysters.*

Customs districts.	Dredges.		Tongs.		Total.	
	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.
Cherrystone	408,344	$150,655	8,891	$3,171	417,235	$153,826
Alexandria			1,000	300	1,000	300
Tappahannock	136,441	48,627	7,450	2,982	143,891	51,609
Yorktown	14,700	9,027	163,166	62,923	177,866	71,950
Norfolk			387,530	130,648	387,530	130,648
Petersburgh			5,900	1,310	5,900	1,310
Richmond			72,611	24,721	72,611	24,721
Total	559,485	208,309	646,548	226,055	1,206,033	434,364

V.—THE FISHERIES OF THE SOUTH ATLANTIC STATES.

This geographical division embraces the States of North Carolina, South Carolina, and Georgia, and the eastern coast of Florida. The coast line, including the rivers canvassed and all the islands and indentations which support commercial fisheries, is about 5,055 miles long, of which the various States had the following quota: North Carolina, 1,480 miles; South Carolina, 935 miles; Georgia, 1,390 miles; Florida, 1,250 miles.

With the exception of North Carolina this section has no indentations of large size, and the fisheries, except in the rivers, do not attain great importance. The fishery resources of the region are not fully developed, and with the advent of new capital and methods, especially in the oyster and vessel food-fish fisheries, this section will no doubt take a prominent place among the fish-producing regions of the country. One special feature of the fisheries of this region is the extent to which set or staked gill-nets are employed, the number of this form of apparatus being about two-thirds of the number used in the entire coast fisheries of the country.

10,539 persons were engaged in the fisheries and fishery industries of this section in 1888. Of these only a very small proportion, 401, were

in the vessel fisheries; 8,799 were classed as shore fishermen, and 1,336 were shoresmen, factory hands, etc. Of the capital invested, $116,660 was in vessels, $220,224 in boats, $343,159 in apparatus of capture, and $393,846 in shore property and cash capital. The fishery products of the region had a value to the fishermen of $1,196,892, of which the general shore fisheries represented the major portion, followed by the oyster and crustacean fisheries.

NORTH CAROLINA.

The statistics for this State cover the coast fisheries proper and the river fisheries to head of tide water, this being practically to the limit of commercial fishing, except in the case of the Roanoke River, which was canvassed to a distance of 30 miles from its mouth.

Comparing the results of the census of 1880 with the figures for 1888, we find a material increase in the persons employed and capital invested, the former being 46 per cent., while the capital had increased 58 per cent. The value of the catch, however, as obtained in 1888, was 8 per cent. less than in 1880, though the yield itself was enormously greater—43,022,854 pounds in 1888 against 32,249,488 pounds in 1880. This increase, however, is largely menhaden, a cheap product that was not taken in 1880, the fishery having been established since then.

The following are some of the most remarkable changes that have occurred since the census year:

There has been a large increase in the pound-net fishery. In 1880 only 117 pound nets, worth $30,800, were reported, while in 1888 there were 797, with a total value of $68,463, and the catch amounted to 7,898,075 pounds of fish, with a first value of $112,877.

The change in the gill-net fishery has been phenomenal. In the census year only 18,796 gill nets were used; in 1888 the number had reached 61,630.

There has been a gratifying improvement in the yield of the general food-fish fisheries with few exceptions. The output of shad, in which this State ranks among the first, increased from 3,221,263 pounds in 1880 to 5,630,709 pounds in 1888. The catch of mullet has declined almost 50 per cent. There has also been a slight decrease in the oyster fishery.

The porpoise fishery has been established since 1880; in 1888 it amounted to $16,125.

112. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	172	150
On transporting vessels	140	138
On boats *	5,931	6,315
On shore, in factories, fish-houses, etc	1,109	1,101
Total	7,352	7,704

* 1,250 of these, each year, were semi-professionals.

113. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing *	37	$29,000	35	$27,420
Outfit	......	7,135	....	6,145
Vessels transporting †	70	36,425	69	36,100
Outfit	....	3,240	....	3,230
Boats ‡	2,985	157,708	3,151	170,189
Apparatus of capture—vessel fisheries:				
Seines	21	5,800	19	5,000
Tongs	38	154	39	158
Apparatus of capture—shore fisheries:				
Haul seines	684	100,250	713	106,180
Gill nets	54,097	89,608	61,630	102,743
Pound nets	672	57,538	797	68,463
Skim nets and cast nets	701	1,813	721	1,843
Fyke nets	15	265	27	505
Turtle nets	106	160	106	160
Hand lines	515	215	515	215
Tongs and rakes	768	2,062	775	2,077
Shore property	....	195,108	....	192,946
Cash capital	....	80,400	....	78,100
Total	....	766,881	....	801,474

* Tonnage in 1887, 403.73; in 1888, 376.67. † Tonnage in 1887, 694.23; in 1888, 684.35.
‡ Under the classification of boats are included, in 1887, 18 small steam flats worth $22,550; and, in 1888, 19 worth $24,000; these are used to "lay out" the large haul seines.

114. *Table of products.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Alewives	5,962,659	$56,189	5,133,900	$50,836
Alewives, salted	11,855,416	116,899	10,211,627	110,717
Alewives, smoked	4,000	120	4,000	120
Bluefish	519,760	16,633	626,025	20,777
Bluefish, salted	120,576	4,680	110,559	4,255
Catfish	18,814	564	19,381	581
Channel bass	129,105	3,740	140,395	3,865
Chub or black bass	390,649	18,267	417,572	20,960
Chub, salted	1,000	60	1,200	72
Eels	5,945	297	7,016	486
Hickory shad	196,691	6,062	192,161	6,253
Menhaden *	14,756,400	18,446	13,844,400	17,247
Mullet	760,275	24,254	783,875	25,035
Mullet, salted	1,133,823	43,076	976,150	36,016
Perch	385,163	14,353	410,357	15,299
Perch, salted	24,700	638	26,450	676
Pike	22,412	1,056	27,161	1,303
Sea bass	14,785	575	15,115	610
Shad	4,673,164	294,635	5,630,709	292,409
Shad, salted	73,062	3,434	62,720	2,620
Sheepshead	140,585	4,365	155,226	4,797
Sheepshead, salted	40,800	1,602	37,550	1,474
Spots and croakers	87,730	2,817	89,903	2,906
Squeteague	622,340	17,714	675,570	19,885
Squeteague, salted	143,355	4,759	135,030	4,399
Striped bass *	493,086	24,729	553,954	27,763
Striped bass, salted	6,500	215	6,400	218
Sturgeon	237,755	5,112	269,950	5,326
Whiting	18,975	790	20,000	800
Miscellaneous fish	373,420	11,579	510,844	15,793
Miscellaneous fish, salted	128,405	4,208	126,560	4,061
Shrimp	120,110	4,503	124,000	4,650
Crabs	46,520	1,105	46,726	1,110
Terrapin	22,500	3,250	24,750	3,400
Turtle	22,000	1,230	20,600	1,136
Quohaugs *	78,016	3,233	148,048	6,150
Scallops	3,600	160	4,050	180
Oysters *	1,490,860	48,353	1,432,921	46,129
Porpoises	....	9,255	......	16,125
Total	45,124,956	772,95[illegible]	43,022,855	776,435

* Of these species, the following quantities and values represent the output of the vessel fisheries, the entire remaining catch being the result of fisheries prosecuted from shore: Menhaden, 14,756,600 pounds, $18,196, in 1887, and 13,654,400 pounds, $16,998, in 1888; striped bass, 92,300 pounds, $2,779, in 1887, and 69,760 pounds, $2,311, in 1888; quohaugs, 2,000 pounds, $83, in 1887; oysters, 177,835 pounds, $5,173, in 1887, and 122,241 pounds, $3,875, in 1888.

115. *Table showing by apparatus and species the yield of the shore fisheries of North Carolina in 1887, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Haul seines.		Gill nets.		Pound nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	2,701,600	$31,214			3,261,059	$21,975
Alewives, salted	7,785,440	82,342	71,780	$677	3,920,196	32,990
Alewives, smoked					4,000	120
Bluefish	202,000	6,500	212,560	6,675	10,200	408
Bluefish, salted	67,500	2,700	53,076	1,980		
Catfish	10,000	300			8,814	264
Channel bass	95,105	2,700	8,000	200		
Chub or black bass	381,360	17,849			9,289	418
Chub, salted	1,000	60				
Eels					5,945	297
Hickory shad	141,420	4,404	14,086	380	34,935	1,253
Menhaden			199,800	250		
Mullet	583,000	18,638	175,625	5,550	1,650	66
Mullet, salted	793,500	30,690	340,323	12,386		
Perch	216,067	7,069			169,096	7,284
Perch, salted	7,700	248	17,000	390		
Pike	21,674	1,023			738	33
Shad	1,619,012	98,136	2,562,381	166,224	389,921	24,429
Shad, salted	58,100	2,785			14,962	649
Sheepshead	111,585	3,367	12,800	450	950	38
Sheepshead, salted	1,500	30	39,300	1,572		
Spots and croakers	62,230	1,832				
Squeteague	368,030	10,016	182,560	6,225	43,500	658
Squeteague, salted	78,355	2,449	65,000	2,310		
Striped bass	149,422	6,831	46,779	3,491	203,335	11,553
Striped bass, salted			6,500	215		
Sturgeon	47,275	412	188,980	4,670	1,500	30
Miscellaneous fish	200,095	5,743	67,000	2,160	46,325	1,776
Miscellaneous fish, salted	99,155	3,293	28,000	865		
Porpoises		*9,255				
Total	15,802,125	349,886	4,291,550	216,670	8,126,415	107,241

Species.	Fyke nets.		Cast nets and skim nets.		Hand lines.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives							5,962,659	$56,189
Alewives, salted			78,000	$890			11,855,416	116,899
Alewives, smoked							4,000	120
Bluefish					95,000	$3,050	519,760	16,633
Bluefish, salted							120,576	4,680
Catfish							18,814	564
Channel bass					26,000	840	129,105	3,740
Chub or black bass							390,649	18,267
Chub, salted							1,000	60
Eels							5,945	297
Hickory shad	6,250	$25					196,691	6,062
Menhaden							199,800	250
Mullet							760,275	24,254
Mullet, salted							1,133,823	43,076
Perch							385,163	14,353
Perch, salted							24,700	638
Pike							22,412	1,056
Sea bass					14,785	575	14,785	575
Shad			101,850	5,846			4,673,164	294,635
Shad, salted							73,062	3,434
Sheepshead	250	10			15,000	500	140,585	4,365
Sheepshead, salted							40,800	1,602
Spots and croakers					25,500	985	87,730	2,817
Squeteague	3,250	65			25,000	750	622,340	17,714
Squeteague, salted							143,355	4,759
Striped bass	1,250	75					400,786	21,950
Striped bass, salted							6,500	215
Sturgeon							237,755	5,112
Whiting					18,975	790	18,975	790
Miscellaneous fish					60,000	1,900	373,420	11,579
Miscellaneous fish, salted	1,250	50					128,405	4,208
Porpoises								9,255
Total	12,250	225	179,850	6,736	280,260	9,390	28,692,450	690,148

* The value of 3,622 porpoises sold by the fishermen to be made into oil and leather.

116. *Table showing by apparatus and species the yield of the shore fisheries of North Carolina in 1888, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Haul seines.		Gill nets.		Pound nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	2,148,367	$25,886			2,985,533	$24,950
Alewives, salted	6,235,147	72,844	68,200	$653	3,837,780	36,382
Alewives, smoked					4,000	120
Bluefish	216,200	7,080	309,525	10,435	5,300	212
Bluefish, salted	57,500	2,300	53,059	1,955		
Catfish	12,000	360			7,381	221
Channel bass	105,895	2,805	8,000	200		
Chub or black bass	406,922	20,534			10,650	426
Chub, salted	1,200	72				
Eels					7,016	486
Hickory shad	145,100	4,519	13,956	378	33,105	1,356
Menhaden			180,000	249		
Mullet	606,375	19,622	170,000	5,350	1,250	38
Mullet, salted	667,600	24,742	308,550	11,274		
Perch	210,393	6,960			199,964	8,339
Perch, salted	8,350	264	18,100	412		
Pike	26,261	1,263			900	40
Shad	1,731,863	83,763	3,338,352	179,945	433,269	21,631
Shad, salted	45,850	1,957			16,870	663
Sheepshead	116,176	3,545	22,000	660	1,050	42
Sheepshead, salted	1,400	28	35,900	1,436		
Spots and croakers	62,340	1,881				
Squeteague	393,275	10,901	229,395	7,680	24,200	479
Squeteague, salted	76,535	2,426	58,500	1,973		
Striped bass	161,300	6,438	51,157	3,651	270,487	15,288
Striped bass, salted			6,400	218		
Sturgeon	45,800	421	222,500	4,870	1,650	35
Miscellaneous fish	277,174	8,144	91,000	2,850	57,670	2,169
Miscellaneous fish, salted	93,235	3,001	32,075	1,010		
Porpoises		*16,125				
Total	13,852,258	327,881	5,216,669	235,199	7,898,075	112,877

Species.	Fyke nets.		Cast nets and skim nets.		Hand lines.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives							5,133,900	$50,836
Alewives, salted			70,500	$838			10,211,627	110,717
Alewives, smoked							4,000	120
Bluefish					95,000	$3,050	626,025	20,777
Bluefish, salted							110,559	4,255
Catfish							19,381	581
Channel bass					26,500	860	140,395	3,865
Chub or black bass							417,572	20,960
Chub, salted							1,200	72
Eels							7,016	486
Hickory shad							192,161	6,253
Menhaden							180,000	249
Mullet	6,250	$25					783,875	25,035
Mullet, salted							976,150	36,016
Perch							410,357	15,299
Perch, salted							26,450	676
Pike							27,161	1,303
Sea bass					15,115	610	15,115	610
Shad			127,225	7,070			5,630,709	292,409
Shad, salted							62,720	2,620
Sheepshead					16,000	550	155,226	4,797
Sheepshead, salted	250	10					37,550	1,474
Spots and croakers					27,563	1,025	89,903	2,906
Squeteague	3,700	75			25,000	750	675,570	19,885
Squeteague, salted							135,035	4,399
Striped bass	1,250	75					484,194	25,452
Striped bass, salted							6,400	218
Sturgeon							269,950	5,326
Whiting					20,000	800	20,000	800
Miscellaneous fish	2,000	60			83,000	2,570	510,844	15,793
Miscellaneous fish, salted	1,250	50					126,560	4,061
Porpoises								16,125
Total	14,700	295	197,725	7,908	308,178	10,215	27,487,605	694,375

*The value of 6,450 porpoises sold by the fishermen to be made into oil and leather.

117. *Table showing the extent of the menhaden industry of North Carolina.*

Designation.	1887.	1888.
Number of factories in operation	8	6
Value of factories	$34,700	$30,900
Amount of cash capital	$26,100	$24,100
Number of shoresmen employed	109	94
Number of fishermen employed	142	119
Number of steam vessels employed	1	1
Net tonnage	44.15	44.15
Value	$9,000	$9,000
Value of outfit	$2,000	$2,000
Number of sailing vessels employed in fishing	12	9
Net tonnage	167.37	124.79
Value	$9,300	$7,800
Value of outfit	$10,075	$8,325
Number of vessels employed as "carryaways"	12	9
Net tonnage	106.46	78.71
Value	$5,900	$5,550
Value of outfit	$600	$450
Number of menhaden handled	24,594,000	22,964,000
Value to fishermen	$18,446	$17,123
Number of gallons of oil made	98,200	50,400
Value as sold	$24,550	$13,600
Number of tons of scrap produced	1,698	1,555
Value as sold	$42,060	$38,875

SOUTH CAROLINA.

The coast fisheries only are included in these tables; the inquiry prosecuted in the rivers did not generally extend above tide water. For this reason there is not a strictly proper basis for comparison with 1880, but the figures are sufficiently similar in their scope to permit deductions regarding changes, although it should be borne in mind that the information for 1880 covers a wider area than in 1888.

Comparing the figures of 1880 with those for 1888 there appears to have been an increase of 34 per cent. in persons employed and 47 per cent. in capital invested, while the value of the catch has fallen off 23 per cent., the yield of the fisheries declining from 6,143,250 pounds in 1880 to 4,180,848 pounds in 1888.

The shrimp catch has fallen off nearly one-half; the crab product has advanced 65 per cent.; the terrapin yield has increased more than 64 per cent.; there have been less noticeable changes in the output of other species.

118. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	67	69
On transporting vessels	5	5
On boats*	1,183	1,247
On shore, in fish-houses, etc	25	25
Total	1,280	1,346

* 477 of these, each year, were semi-professionals.

119. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing *	14	$15,550	15	$15,850
Outfit		4,750		4,850
Vessels transporting †	2	6,500	2	6,500
Outfit		450		450
Boats	485	18,644	526	19,454
Apparatus of capture—vessel fisheries:				
Hand lines	280	96	300	100
Tongs			2	10
Apparatus of capture—shore fisheries:				
Haul seines	30	2,400	32	3,400
Gill nets	208	8,770	229	10,185
Fyke nets	15	100	22	220
Cast nets	150	750	150	750
Dip nets	68	65	68	65
Pots	10	10	10	10
Hand lines	2,200	220	2,200	220
Tongs	126	625	126	625
Shore property		22,000		22,500
Cash capital		12,000		12,000
Total		92,930		97,189

* Tonnage in 1887, 231.79; in 1888, 240.43. † Tonnage in 1887, 17.42; in 1888, 17.42.

120. *Table of products.**

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Bluefish	158,000	$4,740	150,605	$4,518
Catfish	19,560	588	19,085	540
Channel bass	54,673	1,638	50,600	1,618
Drum	90,065	1,600	75,000	1,400
Hickory shad	12,625	252	13,000	260
Mullet	100,000	3,000	115,665	3,469
Mullet, salted	200,000	7,000	150,000	5,200
Red snapper†	1,200	38	1,365	41
Sea bass†	889,237	28,522	910,326	29,362
Shad	365,772	22,840	432,800	27,050
Sheepshead	101,095	3,040	111,060	3,340
Spots and croakers	51,606	1,640	57,000	1,740
Squeteague	216,605	6,564	206,580	6,260
Striped bass	3,500	190	2,865	171
Sturgeon	182,058	7,068	251,065	9,633
Whiting (*Menticirrus*)	617,685	18,528	600,680	18,014
Miscellaneous fish	293,156	8,899	284,750	8,640
Shrimp	338,000	18,400	358,860	18,860
Crabs	76,000	1,010	69,320	910
Terrapin	40,625	3,550	38,525	3,485
Oysters†	264,075	18,581	281,694	19,146
Total	4,075,537	157,688	4,180,847	163,657

* 8,969 pounds of caviare, worth $936, were made in 1887, and 17,788 pounds, worth $1,858, in 1888.

† Of these species the following quantities were taken in the vessel fisheries, all of the remaining catch being the result of fisheries prosecuted from the shore: Red snapper, 1,200 pounds, valued at $38, in 1887, and 1,365 pounds, valued at $41, in 1888; sea bass, 463,492 pounds, valued at $15,750, in 1887, and 511,433 pounds, valued at $17,396, in 1888; oysters, 8,400 pounds, valued at $240, in 1888.

121. *Table showing by apparatus and species the yield of the shore fisheries of South Carolina in* 1887 *and* 1888, *exclusive of crabs, terrapin, and oysters.*

Apparatus.	Species.	1887.		1888.	
		Pounds.	Value.	Pounds.	Value.
Haul seines	Mullet	94,000	$2,820	94,000	$2,820
	Mullet, salted	200,000	7,000	150,000	5,200
	Sheepshead	10,000	300	12,000	360
	Spots and croakers	15,000	450	15,000	450
	Squeteague	157,000	4,730	147,580	4,450
	Miscellaneous fish	50,000	1,500	40,000	1,200
	Shrimp	8,000	400	12,000	600
	Total	534,000	17,200	470,580	15,080
Gill nets	Hickory shad	12,625	252	13,000	260
	Mullet	5,000	150	20,665	619
	Shad	361,772	22,590	428,800	26,800
	Sturgeon	182,058	7,068	251,065	9,633
	Total	561,455	30,060	713,530	37,312
Fyke nets	Catfish	3,000	80	3,000	80
	Striped bass	3,500	190	2,865	171
	Miscellaneous fish	6,000	240	6,000	240
	Total	12,500	510	11,865	491
Cast nets and dip nets.	Mullet	1,000	30	1,000	30
	Shad	4,000	250	4,000	250
	Squeteague	1,000	40	1,000	40
	Shrimp	330,000	18,000	346,860	18,260
	Total	336,000	18,320	352,860	18,580
Hand lines	Bluefish	158,000	4,740	150,605	4,518
	Catfish	16,560	508	16,085	460
	Channel bass	54,673	1,638	50,600	1,618
	Drum	90,065	1,600	75,000	1,400
	Sea bass	425,745	12,772	398,895	11,966
	Sheepshead	91,095	2,740	99,060	2,980
	Spots and croakers	36,606	1,190	42,000	1,290
	Squeteague	58,605	1,794	58,000	1,770
	Whiting (*Menticirrus*)	617,685	18,528	600,680	18,014
	Miscellaneous fish	237,156	7,159	238,750	7,200
	Total	1,786,190	52,669	1,729,675	51,216
	Grand total	3,230,145	118,759	3,278,510	122,679

GEORGIA.

The canvass upon which the tables are based covered all coast fisheries and the river fisheries to the head of tide water; this field practically embracing the entire commercial fisheries of the State with the exception of those in the upper Savannah and Altamaha Rivers.

The fisheries of this State have generally declined since 1880, noticeably in personnel, capital invested, and value of catch; but the actual output of the fisheries in 1888 exceeded by about 600,000 pounds the catch reported in 1880.

In the fisheries for sturgeon, alewives, and mullet, there has been a marked decadence; while the vessel fishery shows an increase in material from 1 vessel in 1880 to 12 in 1888. These engage chiefly in the oyster industry, but also fish for red snappers, sea bass, and terrapin.

122. *Table of persons employed.*

How engaged.	1887.	1888.
In vessel fisheries	23	32
In shore fisheries*	490	492
On shore	114	114
Total	627	638

* 200 of these, each year, were semi-professional.

123. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing*	10	$5,775	12	$8,875
Outfit	....	2,540	....	2,940
Boats	367	5,241	368	5,246
Apparatus of capture—vessel fisheries:				
Seines	6	360	6	360
Hand lines	....	....	50	5
Tongs	20	100	22	110
Apparatus of capture—shore fisheries:				
Haul seines	20	400	20	400
Gill nets	157	7,710	159	7,730
Cast nets	126	630	126	630
Fyke nets	14	310	14	310
Pound nets	5	1,000	6	1,200
Hand lines	816	80	826	90
Tongs	122	560	122	560
Shore property	....	27,100	....	27,100
Cash capital	....	10,000	....	10,000
Total	....	61,806	....	65,556

* Tonnage in 1887, 90.25; in 1888, 129.41.

124. *Table of products.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Alewives	25,065	$376	24,360	$365
Bluefish	6,850	280	5,895	236
Catfish	67,685	1,692	66,860	1,658
Channel bass	19,900	440	20,685	470
Drum	10,495	312	10,505	345
Hickory shad	13,625	260	14,000	267
Mullet	46,685	1,900	48,000	1,960
Red snapper*	....	....	3,000	150
Sea bass*	4,500	135	7,250	267
Shad	255,200	18,760	263,200	19,000
Sheepshead	8,085	265	7,885	258
Spots and croakers	10,865	440	10,500	425
Squeteague	66,860	2,640	67,068	2,720
Striped bass	11,000	880	11,000	880
Sturgeon	191,600	8,464	174,250	6,978
Whiting	10,900	416	10,000	400
Miscellaneous fish	98,565	3,500	99,625	3,544
Shrimp	185,000	6,500	190,650	6,800
Terrapin*	34,650	5,775	34,950	6,075
Crabs	44,660	760	43,866	742
Oysters*	770,600	26,950	844,200	29,370
Total	1,882,790	80,745	1,957,749	82,910

* Of these species, the following quantities and values represent the yield of the vessel fisheries: Red snapper, 3,000 pounds, $150, in 1888; sea bass, 2,000 pounds, $100, in 1888; terrapin, 23,400 pounds, $3,900, in 1887, and 20,700 pounds, $3,450, in 1888; oysters, 148,600 pounds, $4,200, in 1887, and 207,200 pounds, $5,920, in 1888.

NOTE.—21,748 pounds of caviare, valued at $2,068, were prepared in 1887, and 21,412 pounds, valued at $2,569, in 1888.

125. *Table showing by apparatus and species the yield of the shore fisheries of Georgia in 1887 and 1888, exclusive of oysters and crabs.*

Apparatus.	Species.	1887.		1888.	
		Pounds.	Value.	Pounds.	Value.
Gill nets	Channel bass	10,900	$240	11,685	$270
	Hickory shad	13,625	260	14,000	267
	Mullet	27,685	1,130	27,000	1,110
	Shad	252,800	18,580	261,200	18,850
	Squeteague	35,860	1,400	36,068	1,480
	Sturgeon	191,600	8,464	174,250	6,978
	Miscellaneous fish	10,000	400	10,000	400
	Total	542,470	30,474	534,203	29,355
Haul seines	Mullet	5,000	200	5,000	200
	Spots and croakers	2,000	80	2,000	80
	Miscellaneous fish	6,000	240	6,000	240
	Shrimp	14,000	700	16,000	800
	Terrapin	11,250	1,875	14,250	2,625
	Total	38,250	3,095	43,250	3,945
Cast nets	Catfish	6,000	120	5,860	115
	Mullet	14,000	570	16,000	650
	Miscellaneous fish	15,000	600	17,625	704
	Shrimp	171,000	5,800	174,650	6,000
	Total	206,000	7,090	214,135	7,469
Pound nets and fyke nets.	Alewives	25,065	376	24,360	365
	Catfish	35,000	900	35,000	900
	Shad	2,400	180	2,000	150
	Striped bass	11,000	880	11,000	880
	Miscellaneous fish	23,000	560	23,000	560
	Total	96,465	2,896	95,360	2,855
Hand lines	Bluefish	6,850	280	5,895	236
	Catfish	26,685	672	26,000	643
	Channel bass	9,000	200	9,000	200
	Drum	10,495	312	10,505	345
	Sea bass	4,500	135	5,250	167
	Sheepshead	8,085	265	7,885	258
	Spots and croakers	8,865	360	8,500	345
	Squeteague	31,000	1,240	31,000	1,240
	Whiting	10,900	416	10,000	400
	Miscellaneous fish	44,565	1,700	43,000	1,640
	Total	160,945	5,580	157,035	5,474
	Grand total	1,044,130	49,135	1,043,983	49,098

FLORIDA.

The fisheries of the west coast of Florida are so much more important than those on the Atlantic shore of the State that the tables have been discussed under the Gulf fisheries rather than make separate sets of statistics for the two sections. In tables 2, 4, 6, 10, and 16, constituting a portion of the general statistics, in which the geographical divisions of the coast are observed, the figures for the two sides of the State have been included in their respective sections.

The figures which properly belong to the east coast of Florida for the year 1888 may be briefly given as follows:

Persons employed:	
Vessel fishermen	10
Shore fishermen	745
Shoresmen and factory hands	96
Total	851
Apparatus and capital:	
Vessels (53.71 tons)	3
Boats	482
Seines	45
Gill nets	421
Total investment, including shore property and cash capital	$109,670
Value of products:	
General food-fish	$149,012
Mollusks	13,104
Reptiles	5,876
Crustaceans	5,894
Total	173,886

VI.—FISHERIES OF THE GULF STATES.

The coast line of the Gulf States has an approximate length of 6,875 miles, including the indentations. Of this amount the western side of Florida contributes 2,820 miles, Alabama 180 miles, Mississippi 215 miles, Louisiana 1,650 miles, and Texas 2,010 miles.

In no other section of the country has the percentage of increase been so marked as in the Gulf States since 1880, although the actual advance has been less than in some other regions. The increase has been especially noticeable in the oyster fishery and in the number of vessels and boats employed, this section ranking next to the Middle and New England States in the latter respect. Next to the general food-fish fisheries, which yield the largest returns, the oyster fishery is of the greatest importance, followed by the sponge, crustacean, and reptilian fisheries, the last named, although the least remunerative, being of greater extent than the combined reptilian fisheries of all other sections.

The fisheries of this region gave employment in 1888 to 9,543 persons, of whom 1,639 were vessel fishermen, 6,364 shore fishermen, and 1,540 factory hands, preparators, etc. The capital invested amounted in the aggregate to $1,884,710, of which $504,648 represented vessels and their outfits, $371,332 boats, $107,250 apparatus of capture, and $901,480 shore property and cash capital. The yield of the fisheries was valued at $1,819,745.

FLORIDA.

The statements given in these tables cover the commercial fisheries of the State, with the exception of a limited amount of fishing in some of the small lakes and minor rivers and the business of hunting alligators. The statistics practically cover the same ground as the census of 1880, and therefore afford a very satisfactory basis for comparison.

Speaking in general terms, there has been a marked increase during the past eight years in the three grand items of persons employed, capital, and value of catch. The increase in capital is found chiefly in boats, nets, seines, oyster apparatus, and shore property, and this, together with the increase in personnel, is due to the development of certain fisheries and the establishment of these industries at points where they were not prosecuted in the census year.

There is little change in the vessel fishery, for the reason that there is a natural limit to the sponge trade, and the high tariff on fish in Cuban markets has held in check the development of the smack fishery.

The shad catch shows a marvelous increase—from 251,700 pounds in 1880 to 1,444,000 pounds in 1888. There has also been a marked improvement in the mullet fishery, amounting to 200 per cent. in the catch.

There has been a large increase in the red-snapper fishery, but a decline in the grouper catch; the combined output of the two species, however, is about 1,000,000 pounds more than in 1880.

The oyster industry is no less noticeable for improvement. Canning establishments have recently been located on the east coast, and a large business has been built up. In 1888 the product was 239,195 bushels against 78,600 bushels in 1880.

That portion of the figures in the accompanying tables which is to be credited to the west coast, for the year 1888, may be briefly summarized as follows:

Persons employed:	
Vessel fishermen	1,045
Shore fishermen	1,831
Shoresmen and factory hands	190
Total	3,066
Apparatus and capital:	
Vessels (2,486.37 tons)	141
Boats	1,159
Seines	93
Gill nets	621
Pound nets	3
Total investment, including shore property and cash capital	$613,736
Value of products:	
General food-fish	$319,280
Mollusks	44,448
Reptiles	10,978
Sponge	253,690
Total	628,396

126. *Table of persons employed*, 1888.

How engaged.	No.
On fishing vessels	1,029
On transporting vessels	26
On boats	2,576
On shore, in factories, etc	286
Total	3,917

127. *Table of apparatus and capital*, 1888.

Designation.	No.	Value.
Vessels fishing (tonnage 2,388.11)	135	$218, 575
Outfit		120, 954
Vessels transporting (tonnage 98.26)	9	12, 100
Outfit		2, 520
Boats	1, 641	136, 148
Apparatus of capture—vessel fisheries:		
Haul seines	19	2, 100
Gill nets	23	575
Hand lines	237	384
Tongs	16	96
Sponge outfits		1, 026
Apparatus of capture—shore fisheries:		
Haul seines	119	8, 490
Gill nets	1, 019	40, 738
Pound nets	3	1, 800
Cast nets	241	1, 217
Hand lines	1, 055	192
Tongs and rakes	408	2, 296
Sponge outfits		1, 050
Shore property		143, 145
Cash capital		30, 000
Total		723, 406

128. *Table of products*, 1888.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angel-fish			2, 000	$60	2, 000	$60
Black bass or trout			70, 000	2, 950	70, 000	2, 950
Bluefish			245, 787	5, 212	245, 787	5, 212
Bream			3, 500	87	3, 500	87
Catfish			27, 800	480	27, 800	480
Channel bass			405, 557	11, 154	405, 557	11, 154
Crevalle			19, 810	198	19, 810	198
Drum			55, 126	1, 118	55, 126	1, 118
Flounders			7, 333	144	7, 333	144
Grouper	378, 961	$11, 087	5, 000	100	383, 961	11, 187
Grunt			6, 000	120	6, 000	120
Jurel			24, 975	497	24, 975	497
Kingfish			233, 661	6, 640	233, 661	6, 640
Mullet	108, 000	2, 200	4, 030, 703	74, 400	4, 138, 703	76, 600
Mullet, salted	1, 604, 000	36, 996	1, 053, 200	21, 356	2, 657, 200	58, 352
Mullet roe, salted	45, 500	2, 276	93, 300	4, 836	138, 800	7, 112
Perch			15, 000	750	15, 000	750
Pompano			59, 094	5, 336	59, 094	5, 336
Red snapper	3, 024, 497	85, 400	199, 060	5, 931	3, 223, 557	91, 331
Sailor's choice			2, 000	60	2, 000	60
Sea bass or blackfish			3, 000	75	3, 000	75
Shad			1, 448, 000	89, 630	1, 448, 000	89, 630
Sheepshead			557, 431	13, 817	557, 431	13, 817
Skipjack or lady fish (*Albula*)			8, 652	86	8, 652	86
Spanish mackerel			140, 629	7, 166	140, 629	7, 166
Spots and croakers			28, 435	819	28, 435	819
Squeteague			511, 297	15, 064	511, 297	15, 064
Sturgeon			50, 294	2, 967	50, 294	2, 967
Whiting			22, 800	840	22, 800	840
Miscellaneous fish			2, 011, 875	47, 295	2, 011, 875	47, 295
Miscellaneous fish, salted			550, 000	10, 020	550, 000	10, 020
Refuse fish			225, 000	1, 125	225, 000	1, 125
Sponge	185, 346	185, 346	68, 344	68, 344	253, 690	253, 690
Shrimp			152, 000	5, 800	152, 000	5, 800
Crabs			2, 096	94	2, 096	94
Terrapin			10, 100	1, 220	10, 100	1, 220
Turtle	84, 390	6, 430	140, 181	9, 204	224, 571	15, 634
Quohaugs			2, 475	154	2, 475	154
Oysters	151, 690	4, 202	1, 522, 675	53, 196	1, 674, 365	57, 398
Total	5, 582, 384	333, 937	14, 014, 700	468, 345	19, 597, 084	802, 282

NOTE.—The manufactured product consisted of 2,000 pounds of caviare, valued at $250.

129. *Summary by customs districts of the vessel fisheries of Florida in* 1888.

Customs district.	No. of vessels fishing.	Net tonnage.	Value of vessels.	Value of outfit, gear, provisions, fuel, etc.	Number and nationality of fishermen.					Value of catch.
					Americans.	British.	Italians.	All others.	Total.	
Fernandina	1	32.89	$1,200	$600	5	....	......	....	5	$800
Key West	82	1,303.57	137,125	77,860	248	457	......	....	705	208,736
St. Mark's	3	45.58	3,950	1,268	15	5	......	....	20	2,690
Apalachicola	11	91.19	6,950	4,400	62	....	......	....	62	17,104
Pensacola	37	914.88	69,350	40,987	207	....	15	15	237	104,607
Total	134	2,388.11	218,575	125,115	537	462	15	15	1,029	333,937

Customs district.	No. of vessels transporting.	Net tonnage.	Value of vessels.	Value of outfit, provisions, etc.	Number and nationality of crew.					Value of products transported.
					Americans.	British.	Italians.	All others.	Total.	
Fernandina	2	20.82	$2,000	$500	4	....	......	....	4	$8,570
Key West	4	50.03	7,700	1,700	15	....	......	....	15	30,658
St. Marks	3	27.41	2,400	320	7	....	......	....	7	16,991
Apalachicola	....	....	....	....	....	....	......	....	......	....
Pensacola	....	....	....	....	....	....	......	....	......	....
Total	9	98.26	12,100	2,520	26	....	......	....	26	56,219

130. *Table showing the extent of the sponge fishery of Florida in* 1888

Fishing port.	Vessel fishery.						
	Vessels.				No. of fishermen.	Product.	
	No.	Net tonnage.	Value.	Value of apparatus and outfit.		Pounds of sponge.	Value to fishermen.
Key West	74	1,132.43	$116,725	$68,700	659	175,946	$175,946
Cedar Keys	1	18.50	1,000	258	7	600	600
St. Mark's	..	....	....	....	......	....	....
Apalachicola	*7	52.49	4,900	3,560	41	8,800	8,800
Total	82	1,203.42	122,625	†72,518	707	185,346	185,346

Fishing port.	Shore fishery.						Total.			
	Boats.			No. of fishermen.	Product.		Capital invested.	No. of fishermen.	Pounds of sponge.	Value to fishermen.
	No.	Value.	Value of apparatus and outfit.		Pounds of sponge.	Value to fishermen.				
Key West	300	$28,650	$30,000	300	62,092	$62,092	$244,075	959	238,038	$238,038
Cedar Keys	3	532	150	5	1,752	1,752	1,940	12	2,352	2,352
St. Mark's	3	632	150	5	500	500	782	5	500	500
Apalachicola	24	2,756	1,408	40	4,000	4,000	12,624	81	12,800	12,800
Total	‡330	32,570	31,708	350	68,344	68,344	259,421	1,057	253,690	253,690

* Including four vessels that also engaged in other fisheries during a portion of the year.
† This amount includes the value of 311 rowboats, valued at $4,912, used by the crews of the vessels.
‡ Including 170 rowboats, valued at $2,720.

ALABAMA.

The data obtained for this State cover the coast fisheries only.

Compared with the census year the fishery industries of Alabama show a decline in personnel and catch, though there has been considerable increase in the capital invested. The change in the last-mentioned particular is due entirely to the greater amount of shore property shown in the returns for 1888.

One of the most noticeable changes has occurred in the red-snapper fishery, the catch having declined from 360,000 pounds in 1880 to 85,964 pounds in 1888. This is because Pensacola is more favorably situated than Mobile for prosecuting this industry, and has absorbed the greater part of it.

Contrary to the rule in the Gulf States, there has been a decline in the oyster fishery, the catch having fallen off from 104,500 bushels in 1880 to 76,125 in 1888.

The mullet fishery has increased about 100 per cent. in quantity and value of catch.

The fisheries of Alabama are the least important of any of the coast States, but with the present activity in developing oyster grounds its fishery interests may advance materially in the near future.

131. *Table of persons employed*, 1888.

How engaged.	Number.
On vessels	63
On boats	195
In factories and other shore houses	60
Total	318

132. *Table of apparatus and capital*, 1888.

Designation.	Number.	Value.
Vessels (265.44 tons)	26	$22,400
Outfit	....	5,350
Boats	131	6,810
Apparatus of capture:		
Seines, nets, etc	46	4,420
Tongs, rakes, and minor apparatus	....	740
Shore property, accessories, land, etc	....	14,184
Cash capital	....	8,000
Total capital	....	61,904

133. *Table of products*, 1888.

Species.	Pounds.	Value.
Red snapper	85,964	$2,886
Sea trout	227,500	7,800
Mullet	262,500	6,700
Mixed fish	385,000	15,000
Shrimps	43,750	5,000
Oysters	532,875	32,174
Crabs	96,000	6,000
Total	1,633,589	75,560

MISSISSIPPI.

Only the coast fisheries are included in the tables for this State.

The fishing industries of Mississippi are remarkable for having increased more in all directions since the census year than those of any other State. In personnel there has been an increase of 642 per cent.; in capital, 3,646 per cent.; in catch, 900 per cent., and in value of catch, 928 per cent. This advance is due to the establishment of a large vessel fishery, which did not exist in 1880, and to a phenomenal development of the oyster industry, the product of which in the census year was only 25,000 bushels, worth $10,000, while in 1888 it was 767,205 bushels, valued (at first hand) at $157,463. This industry is developing with unusual rapidity, the catch in 1888 exceeding that of the previous year by 186,105 bushels. Canneries are being established and there is much activity in developing and working grounds.

The general food-fish fisheries have also developed rapidly in recent years, but there are no figures available for making satisfactory comparisons.

134. *Table of persons employed.*

How engaged.	1887.	1888.
On vessels	114	143
On boats	*379	437
On shore, in canneries, etc	660	800
Total	1,153	1,380

*13 in 1887 and 14 in 1888 were semi-professionals.

135. *Table of apparatus and capital.*

How engaged.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing*	34	$20,420	42	$24,600
Outfit		7,476		9,305
Boats	240	14,691	256	14,526
Apparatus of capture—vessel fisheries:				
Seines	20	1,750	20	1,750
Tongs	130	780	164	996
Sponge outfit		5		5
Apparatus of capture—shore fisheries:				
Seines	24	2,300	24	2,250
Gill nets	13	430	14	505
Cast nets	8	48	8	48
Lines		2		3
Tongs	274	1,734	322	1,900
Shore property		78,474		93,194
Cash capital		156,650		180,550
Total		284,760		329,632

* Tonnage in 1887, 295.93; in 1888, 374.42.

136. *Table of products.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Blackfish	18,800	$946	19,100	$1,026
Black bass	4,000	200	4,500	225
Bluefish	72,700	3,593	78,100	3,583
Bream (*Lepomis*)	42,600	1,073	44,900	1,310
Buffalo fish	70,200	702	71,300	713
Catfish	68,100	1,248	70,250	1,320
Drum	1,800	90	2,000	100
Flounders	44,600	1,804	47,575	1,928
Mullet	233,200	2,556	233,050	2,567
Perch or sunfish	62,800	2,547	65,100	2,644
Pickerel	8,500	340	10,300	412
Pompano	10,750	1,203	11,550	1,335
Redfish	140,525	6,396	164,800	7,651
Sheepshead	123,750	5,719	127,800	5,792
Spadefish	16,600	588	19,750	775
Spanish mackerel	30,100	2,066	33,700	2,430
Spots and croakers	75,000	1,982	78,850	2,083
Trout (*Cynoscion*)	258,200	12,438	279,900	13,336
Shrimp*	1,144,800	23,646	1,092,800	22,566
Crabs, hard	38,400	1,030	16,500	468
Crabs, soft	15,000	500	40,200	1,160
Oysters*	4,067,700	118,974	5,370,435	157,463
Sponge*	50	75	550	825
Total	6,548,175	189,716	7,883,010	231,712

*Of these species the following quantities and values represent the results of vessel fisheries, all the remaining products being the output of fisheries prosecuted from the shore: Shrimp, 785,600 pounds worth $15,762 in 1887, and 767,000 pounds worth $15,300 in 1888; oysters, 1,221,675 pounds worth $34,905 in 1887, and 1,586,760 pounds worth $47,603 in 1888; sponge, 50 pounds worth $75 in 1887, and 550 pounds worth $825 in 1888.

137. *Table showing by apparatus and species the yield of the shore fisheries of Mississippi in* 1887 *and* 1888, *exclusive of the shellfish and crustacean fisheries.*

Species.	Seines.				Gill nets.			
	1887.		1888.		1887.		1888.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Blackfish	18,800	$946	19,100	$1,026				
Black bass					4,000	$200	4,500	$225
Bluefish	72,700	3,593	78,100	3,583				
Bream (*Lepomis*)	37,600	973	39,400	1,200	5,000	100	5,500	110
Buffalo fish					70,200	702	71,300	713
Catfish	46,400	834	48,400	883	21,700	414	21,850	437
Drum					1,800	90	2,000	100
Flounders	42,600	1,704	45,075	1,803	2,000	100	2,500	125
Mullet	213,200	2,156	208,050	2,067	20,000	400	25,000	500
Perch or sunfish	40,800	1,631	41,700	1,668	22,000	916	23,400	976
Pickerel					8,500	340	10,300	412
Pompano	10,750	1,203	11,550	1,335				
Redfish	133,025	6,021	156,300	7,226	7,500	375	8,500	425
Sheepshead	121,250	5,594	124,800	5,642	2,500	125	3,000	150
Spadefish	16,600	588	19,750	775				
Spanish mackerel	30,100	2,066	33,700	2,430				
Spots and croakers	71,400	1,802	74,850	1,883	3,600	180	4,000	200
Trout (*Cynoscion*)	205,000	9,778	226,650	10,673	53,200	2,660	53,250	2,663
Total	1,060,225	38,889	1,127,425	42,194	222,000	6,602	235,100	7,036

SUMMARY.

Apparatus.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Seines	1,060,225	$38,889	1,127,425	$42,194
Gill nets	222,000	6,602	235,100	7,036
Total	1,282,225	45,491	1,362,525	49,230

LOUISIANA.

The tables for this State include, in addition to the coast fisheries, the fishing prosecuted on the Mississippi River below New Orleans, and on Lakes Pontchartrain and Borgne.

Next to Mississippi, the fisheries of Louisiana have had a greater percentage of increase than those of any other Gulf State. The development in the number of vessels and boats employed is especially remarkable; of the former, there were 49 in 1880, and 116 in 1888; while the boats have increased from 165 to 2,347. Among the special fisheries, the shrimp shows an enormous advance, the catch being about 13 times greater than in 1880. The catch of other crustaceans was also very much larger than shown by the census. The oyster industry has also improved materially, the product being more than double what it was in 1880. In the aggregate the output has increased from 6,996,000 pounds to 19,121,056 pounds.

138. *Table of persons engaged.*

How engaged.	1887.	1888.
On vessels fishing	310	290
On vessels transporting	27	29
On boats	2,384	2,527
On boats transporting	527	541
On shore, in canneries, etc	359	371
Total	3,607	3,758

139. *Table of apparatus and capital.*

Designation	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing*	113	$53,020	108	$49,045
Outfit		18,871		17,739
Vessels transporting†	11	8,900	8	6,850
Outfit		4,465		4,335
Boats	2,216	140,765	2,347	146,444
Apparatus of capture—vessel fisheries:				
Seines	18	1,435	19	1,490
Tongs	265	1,833	245	1,696
Lines		53		27
Apparatus of capture—shore fisheries:				
Seines	127	11,875	134	12,275
Cast nets	536	1,668	551	1,714
Dip nets	4,108	3,610	4,255	3,782
Small traps	4,210	1,853	4,280	1,870
Tongs	808	5,252	867	5,636
Lines		6,733		7,527
Miscellaneous		6,105		6,250
Shore property		214,429		234,047
Cash capital		152,140		164,200
Total		633,007		664,927

*Tonnage in 1887, 821.86; in 1888, 779.90. †Tonnage in 1887, 71.26; in 1888, 52.56.

140. *Table of products.*

Species.	Vessel fisheries.				Shore fisheries.			
	1887.		1888.		1887.		1888.	
	Pounds	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Black bass					64, 850	$3, 430	69, 200	$3, 716
Bream and sunfish					210, 200	13, 320	209, 500	13, 340
Bluefish	12, 550	$812	14, 720	$915				
Buffalo fish	9, 431	203	9, 320	196	985, 000	19, 050	992, 500	19, 241
Catfish	18, 895	378	18, 850	375	2, 184, 000	41, 795	2, 316, 272	43, 984
Flounders	6, 975	647	7, 970	737	11, 500	1, 150	12, 000	1, 200
Mullet					252, 700	8, 690	252, 714	8, 710
Perch, white and black					13, 000	1, 120	13, 300	1, 330
Pompano	5, 275	692	6, 190	848	24, 534	2, 980	24, 800	3, 015
Redfish	58, 626	2, 458	57, 535	2, 435	230, 400	7, 452	230, 900	7, 545
Red snapper	130, 860	4, 615	150, 300	5, 250				
Rock bass					56, 333	3, 380	50, 334	3, 020
Sheepshead	27, 670	1, 991	27, 005	1, 974	333, 900	20, 402	339, 400	21, 334
Spanish mackerel	19, 012	1, 866	21, 640	2, 153	100, 100	10, 010	104, 000	10, 400
Spots and croakers	26, 980	2, 303	26, 695	2, 273	27, 000	2, 700	28, 500	2, 850
Striped bass					11, 335	680	33, 334	2, 000
Trout (*Cynoscion*)	41, 170	2, 209	42, 472	2, 302	482, 606	22, 766	479, 746	22, 776
Yellow-tail	14, 960	914	14, 815	890	70, 850	3, 420	73, 400	3, 574
Miscellaneous	65, 120	2, 680	64, 000	2, 572	206, 300	9, 855	213, 800	9, 260
Shrimp	98, 680	1, 968	107, 075	2, 147	6, 711, 000	94, 440	6, 835, 625	91, 305
Crayfish					138, 000	6, 900	140, 000	7, 000
Crabs, hard	27, 450	1, 278	27, 000	1, 250	810, 000	11, 950	824, 100	12, 180
Crabs, soft	10, 388	682	10, 200	665	123, 000	5, 880	133, 200	6, 500
Oysters	1, 637, 489	59, 538	1, 738, 744	62, 545	3, 110, 100	155, 625	3, 301, 200	168, 275
Turtle					87, 250	2, 250	98, 700	2, 513
Alligator hides					(*)	45, 025	(*)	58, 225
Total	2, 211, 531	85, 234	2, 344, 531	89, 527	16, 243, 958	494, 270	16, 776, 525	523, 293

Species.	Total.			
	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Black bass	64, 850	$3, 430	69, 200	$3, 716
Bream and sunfish	210, 200	13, 320	209, 500	13, 340
Bluefish	12, 550	812	14, 720	915
Buffalo fish	994, 431	19, 253	1, 001, 820	19, 437
Catfish	2, 202, 895	42, 173	2, 335, 122	44, 359
Flounders	18, 475	1, 797	19, 970	1, 937
Mullet	252, 700	8, 690	252, 714	8, 710
Perch, white and black	13, 000	1, 120	13, 300	1, 330
Pompano	29, 809	3, 672	30, 990	3, 863
Redfish	289, 026	9, 910	288, 435	9, 980
Red snapper	130, 860	4, 615	150, 300	5, 250
Rock bass	56, 333	3, 380	50, 334	3, 020
Sheepshead	361, 570	22, 393	366, 405	23, 308
Spanish mackerel	119, 112	11, 876	125, 640	12, 553
Spots and croakers	53, 980	5, 003	55, 195	5, 123
Striped bass	11, 335	680	33, 334	2, 000
Trout (*Cynoscion*)	523, 776	24, 975	522, 218	25, 078
Yellow-tail	85, 810	4, 334	88, 215	4, 464
Miscellaneous	271, 420	12, 535	277, 800	11, 832
Shrimp	6, 809, 680	96, 408	6, 942, 700	93, 452
Crayfish	138, 000	6, 900	140, 000	7, 000
Crabs, hard	837, 450	13, 228	851, 100	13, 430
Crabs, soft	133, 388	6, 562	143, 400	7, 165
Oysters	4, 747, 589	215, 163	5, 039, 944	230, 820
Turtle	87, 250	2, 250	98, 700	2, 513
Alligator hides		45, 025		58, 225
Total	18, 455, 489	579, 504	19, 121, 056	612, 820

* Number in 1887, 87,068; in 1888, 116,618.

141. *Table showing by apparatus and species the yield of the shore fisheries of Louisiana in 1887 and 1888, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Seines.				Lines.			
	1887.		1888.		1887.		1888.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Black bass	64, 850	$3, 430	69, 200	$3, 716				
Bream and sunfish	151, 262	8, 605	149, 625	8, 510	25, 625	$2, 050	26, 250	$2, 100
Buffalo fish	978, 400	18, 920	985, 200	19, 097				
Catfish	567, 165	9, 305	588, 933	9, 626	1, 553, 127	31, 168	1, 662, 322	33, 026
Flounders	11, 500	1, 150	12, 000	1, 200				
Mullet	192, 700	6, 590	191, 586	6, 570	20, 000	700	20, 700	725
Perch, white and black	13, 000	1, 120	13, 300	1, 330				
Pompano	24, 534	2, 980	24, 800	3, 015				
Redfish	230, 400	7, 452	230, 900	7, 545				
Rock bass	42, 167	2, 530	41, 167	2, 470	14, 166	850	9, 167	550
Sheepshead	273, 368	14, 369	275, 293	14, 923	60, 532	6, 033	64, 107	6, 411
Spanish mackerel	83, 350	8, 335	87, 800	8, 780	16, 750	1, 675	16, 200	1, 620
Spots and croakers	27, 000	2, 700	28, 500	2, 850				
Striped bass	8, 557	513	27, 223	1, 633	2, 778	167	6, 111	367
Trout (*Cynoscion*)	376, 974	15, 370	372, 484	15, 286	92, 304	6, 694	93, 683	6, 783
Yellow-tail	70, 850	3, 420	73, 400	3, 574				
Miscellaneous fish	147, 150	7, 981	149, 300	7, 364	14, 575	747	14, 750	749
Total	3, 263, 227	114, 770	3, 320, 711	117, 489	1, 799, 857	50, 084	1, 913, 290	52, 331

Species.	Minor apparatus, including cast nets, dip nets, etc.				Total.			
	1887.		1888.		1887.		1888.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Black bass					64, 850	$3, 430	69, 200	$3, 716
Bream and sunfish	33, 313	$2, 665	33, 625	$2, 730	210, 200	13, 320	209, 500	13, 340
Buffalo fish	6, 600	130	7, 300	144	985, 000	19, 050	992, 500	19, 241
Catfish	63, 708	1, 322	65, 017	1, 332	2, 184, 000	41, 795	2, 316, 272	43, 984
Flounders					11, 500	1, 150	12, 000	1, 200
Mullet	40, 000	1, 400	40, 428	1, 415	252, 700	8, 690	252, 714	8, 710
Perch, white and black					13, 000	1, 120	13, 300	1, 330
Pompano					24, 534	2, 980	24, 800	3, 015
Redfish					230, 400	7, 452	230, 900	7, 545
Rock bass					56, 333	3, 380	50, 334	3, 020
Sheepshead					333, 900	20, 402	339, 400	21, 334
Spanish mackerel					100, 100	10, 010	104, 000	10, 400
Spots and croakers					27, 000	2, 700	28, 500	2, 850
Striped bass					11, 335	680	33, 334	2, 000
Trout (*Cynoscion*)	13, 328	702	13, 579	707	482, 606	22, 766	479, 746	22, 776
Yellow-tail					70, 850	3, 420	73, 400	3, 574
Miscellaneous fish	44, 575	1, 127	49, 750	1, 147	206, 300	9, 855	213, 800	9, 260
Total	201, 524	7, 346	209, 699	7, 475	5, 264, 608	172, 200	5, 443, 700	177, 295

TEXAS.

The tables for this State include only what may properly be classed as coast fisheries. Texas has had a remarkable development in its fishery interests during the past 8 years, and in percentage of increase ranks high among the coast States. In personnel there has been an increase since 1880 of 103 per cent.; in capital of 406 per cent.; in catch of 74 per cent., and in value of catch 33 per cent.

Among the important changes the vessel fishery deserves mention. There was no fishery of this character reported in 1880; in 1888 19 vessels were employed in fishing. There appears to have been more or less improvement in most branches of fishing. Perhaps the most important change is in the oyster industry, in which the catch has increased from 95,625 bushels in 1880 to 355,561 bushels in 1888. The large extent of ground on the Texas coast available for cultivation of oysters renders it possible that there will be still greater activity in the oyster trade of this State in the near future.

The turtle fishery, as compared with the figures for 1880, shows a large increase, though it is claimed by the fishermen that there has been a decrease in the abundance of turtles in recent years.

The recent withdrawal of the coast connections with the steamship lines has affected the fisheries considerably, and in many cases has led to changes in locality, much to the detriment of certain sections, with a corresponding improvement elsewhere.

142. *Table of persons employed.*

How engaged.	1887.	1888.
In vessel fisheries	69	69
In shore fisheries	832	833
On shore, in canneries, etc	126	119
Total	1,027	1,021

143. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing*	19	$12,310	19	$12,085
Outfit		3,140		3,090
Boats	738	89,794	752	92,739
Apparatus of capture—vessel fisheries:				
Seines	9	1,310	9	1,310
Turtle nets	33	330	30	300
Lines		12		12
Tongs	27	162	21	126
Apparatus of capture—shore fisheries:				
Seines	114	13,675	116	13,945
Turtle nets	164	1,650	139	1,400
Cast nets	175	615	182	633
Crab traps	127	38	130	39
Lines		490		480
Tongs	334	2,165	344	2,217
Miscellaneous, including spears		770		775
Shore property		58,130		62,210
Cash capital		22,000		23,150
Total		206,591		214,511

* Tonnage in 1887, 188.08; in 1888, 188.08.

144. *Table of products.*

Species.	Vessel fisheries.				Shore fisheries.			
	1887.		1888.		1887.		1888.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish					7,000	$350	6,500	$340
Buffalo fish					9,200	509	12,000	660
Catfish					47,250	2,511	46,500	2,490
Croaker	41,800	$1,467	44,300	$1,551	65,568	2,805	65,609	2,954
Flounders	9,700	388	10,570	421	106,500	4,745	106,800	4,782
Grouper	4,500	135	6,800	204				
Hogfish or capitaine					18,000	810	17,500	788
Jackfish	10,400	416	11,860	472	52,170	1,988	48,000	1,842
Jewfish					4,600	230	4,200	210
Mullet					31,250	1,612	31,650	1,646
Perch					27,000	1,328	28,100	1,370
Pike					21,500	1,065	21,100	1,055
Pompano					2,500	750	2,300	690
Redfish	166,400	5,418	171,580	5,903	838,704	32,761	772,497	31,932
Red snapper	25,000	1,055	30,000	1,125	50,000	3,000	35,000	1,850
Sheepshead	83,540	3,035	85,410	3,202	611,184	25,761	561,307	22,993
Shoemaker (*Elagatis*)					9,000	405	8,500	383
Spanish mackerel					11,000	660	10,800	648
Striped bass					5,800	290	5,500	275
Trout (*Cynoscion*)	94,560	3,307	97,350	3,483	846,124	35,131	774,267	33,226
Miscellaneous fish	11,600	319	8,930	268	273,500	9,199	233,120	8,231
Oysters	169,743	6,100	127,575	4,488	1,623,650	82,175	2,261,350	105,145
Crabs					111,333	4,275	115,333	4,400
Shrimp					254,633	7,950	259,333	7,950
Terrapin					57,780	5,800	47,520	6,480
Turtle	85,000	1,260	75,000	1,125	495,000	7,240	465,000	6,675
Total	702,243	22,900	669,375	22,242	5,580,246	233,350	5,939,786	249,015

Species.	Total vessel and shore fisheries.			
	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Bluefish	7,000	$350	6,500	$340
Buffalo fish	9,200	509	12,000	660
Catfish	47,250	2,511	46,500	2,490
Croaker	107,368	4,272	109,909	4,505
Flounders	116,200	5,133	117,370	5,203
Grouper	4,500	135	6,800	204
Hogfish or capitaine	18,000	810	17,500	788
Jackfish	62,570	2,404	59,860	2,314
Jewfish	4,600	230	4,200	210
Mullet	31,250	1,612	31,650	1,646
Perch	27,000	1,328	28,100	1,370
Pike	21,500	1,065	21,100	1,055
Pompano	2,500	750	2,300	690
Redfish	1,005,104	38,179	944,077	37,835
Red snapper	75,000	4,055	65,000	2,975
Sheepshead	694,724	28,796	646,717	26,195
Shoemaker (*Elagatis*)	9,000	405	8,500	383
Spanish mackerel	11,000	660	10,800	648
Striped bass	5,800	290	5,500	275
Trout (*Cynoscion*)	940,684	38,438	871,617	36,709
Miscellaneous fish	285,100	9,518	242,050	8,499
Oysters	1,793,393	88,275	2,388,925	109,633
Crabs	111,333	4,275	115,333	4,400
Shrimp	254,633	7,950	259,333	7,950
Terrapin	57,780	5,800	47,520	6,480
Turtle	580,000	8,500	540,000	7,800
Total	6,282,489	256,250	6,609,161	271,257

145. *Table showing by apparatus and species the yield of the shore fisheries of Texas in 1887 and 1888, exclusive of the shellfish, crustacean, and reptilian fisheries.*

Species.	Cast nets.				Seines.			
	1887.		1888.		1887.		1888.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bluefish					7,000	$350	6,500	$340
Buffalo fish					9,200	509	12,000	660
Catfish					5,750	311	8,000	420
Croaker					65,568	2,805	65,609	2,954
Flounders					51,500	2,045	48,800	1,982
Hogfish or capitaine					18,000	810	17,500	788
Jackfish					52,170	1,988	48,000	1,842
Jewfish					4,600	230	4,200	210
Mullet	18,750	$1,050	19,750	$1,110	12,500	562	11,900	536
Perch	7,500	450	9,000	510	19,500	878	19,100	860
Pike					21,500	1,065	21,100	1,055
Pompano					2,500	750	2,300	690
Redfish					838,704	32,761	772,497	31,932
Sheepshead					601,184	25,161	550,307	22,333
Shoemaker (*Elagatis*)					9,000	405	8,500	383
Spanish mackerel					11,000	660	10,800	648
Striped bass					5,800	290	5,500	275
Trout (*Cynoscion*)	5,000	200	5,000	200	828,124	34,151	756,767	32,276
Miscellaneous fish					261,500	8,699	221,120	7,731
Total	31,250	1,700	33,750	1,820	2,825,100	114,430	2,590,500	107,915

Species.	Lines.				Spears.			
	1887.		1888.		1887.		1888.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Catfish	41,500	$2,200	38,500	$2,070				
Flounders					55,000	$2,700	58,000	$2,800
Red snapper	50,000	3,000	35,000	1,850				
Sheepshead	10,000	600	11,000	660				
Trout (*Cynoscion*)	13,000	780	12,500	750				
Miscellaneous fish	12,000	500	12,000	500				
Total	126,500	7,080	109,000	5,830	55,000	2,700	58,000	2,800

SUMMARY.

Species.	1887.		1888.		Species.	1887.		1888	
	Lbs.	Value.	Lbs.	Value.		Lbs.	Value.	Lbs.	Value.
Bluefish	7,000	$350	6,500	$340	Redfish	838,704	$32,761	772,497	$31,932
Buffalo fish	9,200	509	12,000	660	Red snapper	50,000	3,000	35,000	1,850
Catfish	47,250	2,511	46,500	2,490	Sheepshead	611,184	25,761	561,307	22,993
Croaker	65,568	2,805	65,609	2,954	Shoemaker	9,000	405	8,500	383
Flounders	106,500	4,745	106,800	4,782	Spanish mackerel	11,000	660	10,800	648
Hogfish or capitaine	18,000	810	17,500	788	Striped bass	5,800	290	5,500	275
Jackfish	52,170	1,988	48,000	1,842	Trout	846,124	35,131	774,267	33,226
Jewfish	4,600	230	4,200	210	Miscellaneous fish	273,500	9,199	233,120	8,231
Mullet	31,250	1,612	31,650	1,646					
Perch	27,000	1,328	28,100	1,370	Total	3,037,850	125,910	2,791,250	118,365
Pike	21,500	1,065	21,100	1,055					
Pompano	2,500	750	2,300	690					

VII.—FISHERIES OF THE PACIFIC STATES.

The shore line covered by the accompanying statistical statements has an approximate length of 4,425 miles, of which California has 1,910 miles, Oregon 1,170 miles, and Washington 1,345 miles. These figures include all the rivers of the coast as far as the limits of commercial fishing.

The vessel fisheries characteristic of this region are those for whales, fur seals, and cod, all of which are of great importance. The whale fishery carried on from this coast is now the most important in the country. The shore fisheries, especially on the California coast and in Puget Sound, are extensive. The river fishery for salmon is the most important in the world, and is the most remunerative fishery of the region, while the canning industry dependent thereon is of great magnitude.

The fisheries of this section have been made the subject of a special report, to which the reader is referred for details.*

There were employed in the fisheries of the Pacific States in 1888 1,879 vessel fishermen, 8,804 shore fishermen, and 3,167 shoresmen and factory hands, making a total of 13,850 persons.

The capital invested, which ranked next to the Middle States in point of value, amounted to $6,498,239, of which $1,682,545 represented vessels and their outfits, $591,985 boats, $1,194,795 apparatus of capture, and $3,082,914 shore property and circulating capital.

The catch, which in value ranked as third among the five coast sections, was worth at first hands $6,379,363. Next to the general food-fish fisheries the most important branches were the fur-seal, whale, and sea-otter industries, and the molluscan fisheries. The crustacean catch was also large.

CALIFORNIA.

The tables for this State cover all the commercial fisheries, including those prosecuted in Alaska, so far as they are controlled by California capital; exception to this, however, is made in the case of the Alaskan salmon fishery.

In general the fisheries of California show a satisfactory improvement since 1880, though there has been a decline in some branches. The figures for 1888 indicate an increase in personnel of 72 per cent., in capital of 136 per cent., and in value of products of 38 per cent. In 1888 the fur-seal and sea-otter fisheries of Alaska were included, these being maintained by California capital. In the foregoing comparisons with 1880 these fisheries have been added to the figures given for California for the census year.

*Report on the Fisheries of the Pacific Coast of the United States, by J. W. Collins.

There has been a material advance in the vessel fisheries of the State, the fleet having increased from 49 to 94 vessels, while the average tonnage is now 128.82 against 107.08 in 1880. The whale fishery has grown to large proportions, and this State is slightly in advance of any other in this industry, so far as value of products is concerned, though the margin of difference over Massachusetts is so small that the relative positions of the two States may be changed at any time. In 1880 there were only 5 whaling vessels in California, but in 1888 the fleet numbered 27 sail. In value of products, this branch of the fisheries has increased more than 300 per cent. since 1880.

Among other conspicuous changes the following may be mentioned: The shrimp fishery has increased 125 per cent.; the oyster industry, which was not reported in 1880, now amounts to over a half million dollars in value of products; the clam fishery has also undergone a great advance, while the abalone fishery has seriously declined.

146. *Table of persons employed*, 1888.

How engaged.	No.
On fishing vessels	1,396
On transporting vessels	147
On boats	3,188
On shore, in canneries, factories, etc	607
Total	5,338

147. *Table of apparatus and capital*, 1888.

Designation.	Number.	Value.
Vessels fishing (tonnage 9,544.49)	69	$741,650
Outfit		372,175
Vessels transporting (tonnage 2,564.32)	25	304,850
Outfit		75,300
Boats	1,354	245,010
Apparatus of capture:		
Gill nets	2,367	256,465
Trammel nets	329	14,735
Seines, bag nets, etc	1,629	57,625
Traps, pots, and fykes	1,490	4,420
Hand lines and trawl lines		21,430
Shore property		323,050
Cash capital		267,500
Total		2,684,210

148. *Table of products*, 1888.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Miscellaneous fish	5,200	$338	17,845,432	$941,968	17,850,632	$942,306
Miscellaneous fish, salted	3,890,393	101,962	1,552,299	47,130	5,442,692	149,092
Oysters			910,000	509,175	910,000	509,175
Clams			2,396,415	78,284	2,396,415	78,284
Abalone shells and meats	940,000	20,750	2,665,920	57,826	3,605,920	78,576
Octopus and squid			244,000	13,620	244,000	13,620
Crayfish			231,060	7,995	231,060	7,995
Crabs			230,000	37,200	230,000	37,200
Shrimp and prawn			4,902,360	141,688	4,902,360	141,688
Terrapin and frogs			60,000	15,060	60,000	15,060
Hair-seal, sea-lion, and walrus skins	(*)	4,205	(†)	1,050		5,255
Fur-seal pelts	(‡)	27,580	(§)	1,549,150		1,576,730
Sea-otter pelts	(‖)	38,500	(¶)	179,159		217,659
Whalebone and ivory	197,060	585,895			197,060	585,895
Whale and seal oil	2,137,192	102,384	54,375	2,450	2,191,567	104,834
	7,169,845	881,614	31,091,861	3,581,755	38,261,706	4,463,369

* 121 in number.
† 666 in number.
‡ 4,455 in number.
§ 100,000 in number.
‖ 385 in number.
¶ 2,286 in number.

OREGON.

All the commercial fisheries of this State are included in the tables, and for the first time the statistics embrace the salmon canning and market fishing on the small coast rivers, where these industries have generally been recently established and have grown to considerable importance.

The specially prominent feature of the fisheries of Oregon is the salmon industry; outside of this the fishery interests have not yet assumed proportions of any magnitude.

In recent years there has been some decline in the salmon fishery, so far as the catch and pack are concerned, although, owing to the increase in price paid the fishermen, there has been an enhancement of first value.

The salmon catch of the State, as reported for 1880, was 39,500,000 pounds, valued at $855,302. It is believed, however, that the entire catch of the Columbia River, for the year last mentioned, has been credited to Oregon, and this should be taken into consideration in noting comparisons. In 1888 the yield of salmon amounted to 23,948,142 pounds, valued at $985,211. So far as other products are concerned there is no basis for comparison in detail; it may be said, however, that there has been a large increase in the general fisheries. The oyster industry has been established since 1880, and the sturgeon fishery likewise. The latter has assumed considerable importance, ranking next to the salmon in productiveness, the yield in 1888 being 970,624 pounds.

149. *Table of persons employed*, 1888.

How engaged.	No.
On transporting vessels	53
On boats	3,045
On shore, in canneries, factories, etc	1,584
Total	4,682

150. *Table of apparatus and capital*, 1888.

Designation.	Number.	Value.
Vessels transporting (tonnage, 422.30)	13	$74,050
Outfit		11,400
Boats	1,545	201,095
Apparatus of capture:		
Gill nets	2,545	322,620
Seines	25	7,260
Pound nets and weirs	56	41,550
Salmon wheels	24	63,613
Minor apparatus		2,900
Shore property		619,294
Cash capital		952,850
Total		2,296,632

151. *Table of products*, 1888.

Species.	Pounds.	Value.
Eels, salted	15,000	$750
Salmon	23,415,242	963,616
Salmon, salted	532,900	21,595
Shad	10,000	500
Smelt	180,000	5,400
Sturgeon	784,424	11,796
Sturgeon, salted	186,200	3,724
Miscellaneous fish	45,500	3,462
Oysters	275,000	6,250
Clams	74,880	7,325
Crayfish	14,325	716
Oil	60,000	1,800
Fertilizer	201,600	1,800
Caviare	96,760	4,840
Total	25,891,831	1,033,574

WASHINGTON.

The tables embrace all fisheries of commercial importance, including the small coast rivers and bays.

As no mention was made of the salmon fishery prosecuted from the Washington side of the Columbia River in 1880, the basis for comparison with that period is not entirely satisfactory. All that can be done is to present such figures as are available.

In general there has been a decided increase since the last census year in the fishery interests of this State, notably in the oyster fishery, the yield of which has advanced from 15,000 to 60,993 bushels; in the salmon fishery, in which the catch in 1880 was reported to be 350,000 pounds and in 1888 was 16,319,736 pounds; in the vessel fishery for food species (including halibut and salt salmon) which has been established in recent years, and the product of which in 1888 amounted to 686,000 pounds. The fur-seal fishery has declined considerably in value, though to a less extent in number of skins.

152. *Table of persons employed*, 1888.

How engaged.	No.
On fishing vessels	267
On transporting vessels	16
On boats	2,571
On shore, in canneries, factories, etc	976
Total	3,830

153. *Table of apparatus and capital*, 1888.

Designation.	Number.	Value.
Vessels fishing (tonnage, 682.16)	13	$52,500
Outfit		28,700
Vessels transporting (tonnage, 70.57)	4	19,100
Outfit		2,820
Boats	1,202	145,880
Apparatus of capture:		
Gill nets	1,130	187,345
Seines	59	44,200
Pound nets and weirs	159	122,400
Salmon wheels	15	45,287
Minor apparatus		2,945
Shore property		333,220
Cash capital		533,000
Total		1,517,397

154. *Table of products*, 1888.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Cod			239,400	$10,820	239,400	$10,820
Halibut	310,000	$9,300	610,000	12,500	920,000	21,800
Halibut, salted	300,000	10,100			300,000	10,100
Salmon			16,185,836	681,808	16,185,836	681,808
Salmon, salted	76,000	2,660	57,900	2,145	133,900	4,805
Miscellaneous fish			1,135,200	33,775	1,135,200	33,775
Fur-seal pelts	(*)	29,458				29,458
Sea-otter pelts	(†)	3,450				3,450
Crabs			1,875	570	1,875	570
Shrimp			5,000	500	5,000	500
Clams			300,000	3,200	300,000	3,200
Oysters			4,066,200	86,574	4,066,200	86,574
Oil			75,000	4,000	75,000	4,000
Total	686,000	54,968	22,676,411	835,892	23,362,411	890,860

* 5,351 in number. † 30 in number.

3.—REPORT OF DISTRIBUTION OF FISH AND EGGS FROM JULY 1, 1888, TO JUNE 30, 1889.

The number of fish and eggs distributed from July 1, 1888, to June 30, 1889, was 348,557,230, an increase of nearly 108,000,000 over the aggregate shipments during the preceding year. The details of the work are shown in the Summary of Distribution, from which it will be seen that important additions have been made to the list of species sent out and noteworthy changes in the character of the fishes deposited.

For example, almost a half million 1-year-old fishes were included in this distribution; among them were nearly 100,000 rainbow trout, 29,000 lake trout, besides many thousands of brook trout, Atlantic salmon, landlocked salmon, wall-eyed pike, red-eye perch, white bass, black bass, crappie, buffalo, and catfish. Of the 33 species distributed the 12 which were furnished in the greatest number were whitefish, shad, wall-eyed pike, cod, sheepshead, sea bass, California salmon, pollock, lake trout, Atlantic salmon, lobster, and landlocked salmon, which were deposited in numbers ranging from over 800,000 of the last-named to more than 135,000,000 of the first-mentioned.

It will be observed that a great many new and valuable species have been added to the list, among them the wall-eyed pike, of which more than 50,000,000 were hatched; the sheepshead, which were deposited in Florida waters to the number of 14,000,000; and a great many of the fishes indigenous to the Mississippi Valley, such as red-eye perch, spotted catfish, buffalo, crappie, white bass, black bass, pickerel, and white perch, or fresh-water drum. The yearling fishes rescued from lakes and sloughs caused by overflow of the Mississippi River, and included in the distribution for 1889, aggregated nearly 100,000. These were collected at Quincy, Ill., and widely distributed in suitable waters.

In shipping California salmon eggs from Baird station to the California State hatchery at Sisson, a new form of transportation box was used, a description of which will be found elsewhere in this report.

The transplanting of lobsters to the Pacific coast was continued in 1889, and upward of 200 adults, of which 54 were egg-bearing females, were carried to Puget Sound.

Summary of distribution for the year ending June 30, 1889.

Species.	Eggs.	Fry.	One year old.	Total.
California salmon	3, 450, 000	6, 000, 000		9, 450, 000
Atlantic salmon	1, 395, 000	855, 000	13, 961	2, 263, 961
Land-locked salmon	510, 000	306, 950	5, 984	822, 934
Rainbow trout	167, 000		97, 213	264, 213
Loch Leven trout	120, 000			120, 000
Brown trout	110, 000			110, 000
Brook trout	207, 000	21, 000	14, 450	242, 450
Lake trout	2, 197, 000	1, 531, 000	29, 035	3, 757, 035
Sälbling	9, 000			9, 000
Whitefish	54, 650, 000	81, 135, 000		135, 785, 000
Shad		96, 454, 000		96, 454, 000
Sole			28	28
Cod		19, 148, 000		19, 148, 000
Pollock		7, 258, 000		7, 258, 000
Mackerel		185, 000		185, 000
White perch (fresh-water drum)			2, 485	2, 485
Scup		30, 000		30, 000
Sheepshead		14, 000, 000		14, 000, 000
Red-eye perch (rock bass)			5, 630	5, 630
Crappie			16, 768	16, 768
Black bass			17, 687	17, 687
Sunfish			3, 688	3, 688
Sea bass		1, 025, 000		1, 025, 000
Wall-eyed pike (pike perch)		50, 190, 000	5, 600	50, 195, 600
White bass			15, 552	15, 552
Pickerel			7, 811	7, 811
Carpsucker			460	460
Tench			1, 530	1, 530
Goldfish			9, 610	9, 610
Carp			170, 402	170, 402
Buffalo			10, 360	10, 360
Catfish			20, 180	20, 180
Lobster		1, 574, 000	(adults) 333	1, 574, 233
Total	62, 815, 000	279, 712, 950	448, 767	342, 976, 717
Loss in transit		5, 540, 000	40, 613	5, 580, 613
Total furnished for distribution	62, 815, 000	285, 252, 950	489, 380	348, 557, 330

Statement of the distribution of California salmon eggs and fry from Clackamas and Baird Stations, season of 1888 and 1889.

Summary.	Eggs.	Fry.
Clackamas Station:		
Deposited in Clackamas River and tributaries		4, 500, 000
Baird Station:		
Forwarded to the Société d'Acclimatation, Paris	100, 000	
Transferred to the Fish Commission Exhibit, Centennial Exposition, Cincinnati, Ohio	*50, 000	
Forwarded to the California Fish Commission for hatching and deposit in the Little Sacramento	3, 300, 000	
Deposited in McCloud River		1, 500, 000
Total	3, 450, 000	6, 000, 000

*Of this number 34,000 fry were produced and deposited in Grand Traverse Bay, near Traverse City, Mich., October 28, 1888.

Statement of the distribution of Penobscot or Atlantic salmon eggs, fry, and 1-year-old fish, for the year ending June 30, 1889.

Disposition.	Number.
Eggs.	
From Bucksport Station:	
New Hampshire State fish commission	200, 000
Benj. Lincoln, Dennysville, Me	40, 000
A. J. Darling, Enfield, Me	50, 000
W. R. Munson, Grand Lake Stream, Maine	200, 000
Charles Dummer, Weld, Me	150, 000
Hatchery on Fulton chain of lakes, Hamilton County, New York	25, 000
Bisby Club Hatchery, Herkimer County, New York	17, 500
Victor Gangoteria, Quito, Ecuador	5, 000
Transferred to U. S. F. C. station, Cold Spring Harbor, New York	707, 500
Total number of eggs	1, 395, 000

Statement of the distribution of Penobscot or Atlantic salmon eggs, fry, and 1-year-old fish, for the year ending June 30, 1889—Continued.

Disposition.	Number.
Fry.	
From Bucksport Station:	
Tributaries of Alamoosook Lake near Orland, Me	19,000
From Grand Lake Stream Station: *	
Grand Lake and tributaries, near Grand Lake Stream, Me	198,000
From Cold Spring Harbor Station: *	
Applicants in Vermont	50,000
Tributaries of Hudson River, New York:	
Balm of Gilead Creek	50,000
Raymond Creek	50,000
Carr's Creek	50,000
Clendon Creek	55,000
Thirteenth Creek	55,000
Minerva Creek	55,000
Martha Creek	50,000
Boreas Creek	50,000
Mill Creek	55,000
Eleventh Creek	50,000
Racket Creek	48,000
Nissequage River, tributary of Long Island Sound	20,000
Total number of fry	855,000
One year old.	
From Bucksport Station:	
Tributaries of Alamoosook Lake near Orland, Me	13,961

* Product of eggs received from Bucksport Station.

Statement of the distribution of landlocked salmon eggs, fry, and 1-year-old fish, for the year ending June 30, 1889.

Disposition.	Number.
Eggs.	
From Grand Lake Stream Station:	
New Hampshire State fish commission	50,000
Minnesota State fish commission	25,000
Iowa State fish commission	25,000
Michigan State fish commission	100,000
Deutscher Fischerei Verein, Berlin, Germany	50,000
Herr von Behr, Schmoldow, Germany	50,000
Richard Young, Edinburgh, Scotland	25,000
Transferred to U. S. F. C. station, Bucksport, Me	25,000
Transferred to U. S. F. C. station, Cold Spring Harbor, N. Y	50,000
Transferred to U. S. F. C. station, Washington, D. C	30,000
Transferred to U. S. F. C. station, Duluth, Minn	50,000
Transferred to U. S. F. C. station, Wytheville, Va	30,000
Total number of eggs	510,000
Fry.	
From Grand Lake Stream Station:	
Grand Lake and tributaries, near Grand Lake Stream, Me	205,000
From Cold Spring Harbor Station: *	
Lake Ronkonkoma, Long Island, New York	10,000
Lake in Passaic County, N. J	10,000
From Central Station: *	
Deer Creek near Belair, Md	27,000
From Wytheville Station: *	
Reed Creek, Wythe County, Va	4,950
From Duluth Station: *	
Lake Superior off mouth of Lester River, Minn	50,000
Total number of fry	306,950
One year old.	
From Bucksport Station:	
Craig's Pond, near Bucksport, Me	5,984

* Product of eggs received from Grand Lake Stream Station.

Statement of the distribution of rainbow trout eggs and 1-year-old fish, for the year ending June 30, 1889.

Disposition.	Number.
Eggs.	
From Northville Station:	
Transferred to U. S. F. C. station, Bucksport, Me	2,500
J. N. Granger, St. Paul, Minn	15,000
New Hampshire State fish commission	10,000
W. A. Scott, Springfield, Ohio	10,000
George M. Fuller, Fair Haven, Vt	10,000
E. Cházari, city of Mexico, for the Republic of Mexico	10,000
From Wytheville Station:	
Delaware State fish commission	8,000
Wyoming fish commission	13,000
Henry Stewart, Walhalla, S. C	8,000
B. S. Hurlbut, Lynn, Mass	8,000
Gordon Land, Mammoth Springs, Ark	25,000
Dr. Thomas Miller, Fincastle, Va	2,500
Midland Counties Fish-Cultural Association, Malvern Wells, England	30,000
Société d'Acclimatation, Paris, France	15,000
Total	167,000
One year old.	
From Northville Station:	
Blue River, near Shelbyville, Ind	1,000
Tippecanoe River, near Monticello, Ind	500
Pleasant Lake, near Angola, Ind	500
Fox Lake, near Angola, Ind	500
James Lake, near Angola, Ind	3,990
Flat Rock River, near Fairland, Ind	500
Brandywine Creek, near St. Paul, Ind	500
Sugar Creek, near Shelbyville, Ind	500
Sylvan Lake, near Rome City, Ind	1,000
To applicants in Indiana	750
Plum Creek, near Buena Vista, Iowa	2,000
Glemaire Creek near Buena Vista, Iowa	1,480
Scatin Creek, near Buena Vista, Iowa	1,000
Floyd Creek, near Buena Vista, Iowa	500
Sin McGill Creek, near McGregor, Iowa	1,500
Bloody Run, near McGregor, Iowa	1,200
Clear Creek, near Lansing, Iowa	520
McGuire Creek, near Lansing, Iowa	500
Village Creek, near Lansing, Iowa	500
Wexford Creek, near Lansing, Iowa	500
Waterloo Creek, near Lansing, Iowa	800
Baldwin's Springs, near Cresco, Iowa	1,000
Mitchell Creek, near Cresco, Iowa	1,000
Nichols Creek, near Cresco, Iowa	500
Catfish Creek, near Dubuque, Iowa	275
Stoney Creek, near London, Ky	1,500
Sinking Creek, near London, Ky	500
Nolin River, near Elizabethtown, Ky	500
To applicants in Kentucky	50
Brandywine Creek, near Niles, Mich	100
Tributaries of Long Lake, near Alpena, Mich	3,000
Cedar River, near Meredith, Mich	3,000
Au Sable River, near Frederick, Mich	1,000
Stacey's Creek, near Vanderbilt, Mich	1,000
Stewart's Creek, near Trowbridge, Mich	1,000
State fish commission of Michigan	4,000
To applicants in Michigan	825
Walton Creek, near Norfolk, Nebr	200
Long Pine Creek, near Long Pine, Nebr	600
Bone Creek, near Ainsworth, Nebr	200
Evergreen Creek, near Wood Lake, Nebr	400
Minnechaduga Creek, near Valentine, Nebr	900
Minnechaduga Creek, near Crookston, Nebr	400
Bordeaux Creek, near Bordeaux, Nebr	200
Chadron Creek, near Chadron, Nebr	200
White River, near Fort Robinson, Nebr	1,100
White River, near Andrews, Nebr	785
State fish commission of Nebraska	500
Applicants in Ohio	1,650
State fish commission of Ohio	2,000
Emory River near Nemo, Tenn	500
From Wytheville Station:	
Crawfish Springs, near Crawfish Spring, Ga	750
Chattooga River, near Trion Factory, Ga	740
Stoney Creek, near London, Ky	1,500
Cove Creek, near Marion, N. C	2,000
North Packollet River, near Tryon City, N. C	150
Sandy Mush Creek, near Trail Branch, N. C	100

Statement of the distribution of rainbow trout eggs and 1-year-old fish, for the year ending June 30, 1889—Continued.

Disposition.	Number.
From Wytheville Station—Continued.	
Green River, near Saluda, N. C	1,000
Johnson's Creek, near Waynesville, N. C	100
To applicants in North Carolina	78
Hoyland's Run, near Williamsport, Pa	497
Tributaries of Antietam Creek, near Waynesboro, Pa	3,000
Tributaries of Susquehanna River, near Phillipsburgh, Pa	1,196
Yellow Breeches Creek, near Mechanicsburgh, Pa	2,800
Clear Fork River, near Robbins, Tenn	1,000
To applicants in Tennessee	300
Wheat Creek, near Liberty, Va	1,000
Cripple Creek, near Speedwell, Va	250
Elk Creek, near Glenwood, Va	1,000
Mill Creek, near Stuart, Va	600
White Top Fork of Laurel River, near Abingdon, Va	1,000
Brumley Creek, near Abingdon, Va	500
Cove Creek, in Wythe County, Va	2,000
North Fork of Clinch River, near Tazewell, Va	500
Staley's Creek, near Marion, Va	2,000
Walker's Creek, near Seddon, Va	1,000
Cowardon Run, near Warm Springs, Va	1,000
Wolf Creek, near Abingdon, Va	500
North River, near Sheflett's, Va	1,480
Buffalo Branch, near Buffalo Gap, Va	997
Shenandoah River, near Staunton, Va	1,000
Dickenson Mill Creek, near Millboro, Va	990
Lick Run, near Millboro, Va	1,000
Bratton's Mill Creek, near Millboro, Va	2,000
To applicants in Virginia	3,780
From Central Station:*	
Delaware State fish commission	500
To applicants in District of Columbia	580
Tributaries of Patuxent River, near Laurel, Md	500
To applicants in Maryland	1,300
Steen's Run, near Mortonville, Pa	1,500
Trout Run, near Shrewsbury, Pa	500
Yellow Breeches Creek, near Mechanicsburgh, Pa	1,000
Walker's Run, near White Rock, Pa	200
Alexander Run, near White Rock, Pa	300
Mehoopany Creek, near Mehoopany, Pa	1,400
To applicants in Pennsylvania	500
Cameron Run, near Alexandria, Va	500
To applicants in Virginia	400
Flowing Springs, near Charlestown, W. Va	300
To applicants in West Virginia	800
Total	97,213

* Of this distribution Northville Station produced 1,978, Wytheville Station 8,302.

SUMMARY.

Station at which produced.	Eggs.	Yearlings.
Northville	57,500	51,650
Wytheville	109,500	49,155
Total	167,000	100,805
Losses:		
In transit		1,639
At Central Station		1,953

Statement of the distribution of Loch Leven trout eggs from Northville Station for the year ending June 30, 1889.

Disposition.	Number of eggs.
Nebraska State fish commission	30,000
New Hampshire State fish commission	30,000
Pennsylvania State fish commission	30,000
Wisconsin State fish commission	30,000
Total	120,000

Statement of the distribution of brown trout eggs (received by international exchange from Berneuchen and Schmoldow, Germany) during the year ending June 30, 1889.

Disposition.	Number of eggs.
From Berneuchen:	
To U. S. F. C. station, Duluth, Minn	44,000
From Schmoldow:	
To New York State fish commission	48,000
To U. S. F. C. station, Northville, Mich	18,000
Total	110,000

Statement of the distribution of brook-trout eggs, fry, and 1-year-old fish for the year ending June 30, 1889.

Disposition.	Number.
Eggs.	
From Northville Station:	
Delaware State fish commission	10,000
Minnesota State fish commission	50,000
New Jersey State fish commission	15,000
Byron S. Hurlbut, Lynn, Mass	5,000
Andrew Egbert, Castalia, Ohio	20,000
A. B. Smith, Bellevue, Ohio	15,000
Midland Counties Fish-Cultural Association, Malvern Wells, England	25,000
E. Cházari, city of Mexico, for the Republic of Mexico	10,000
Transferred to U. S. F. C. station, Bucksport, Me	2,000
Transferred to U. S. F. C. station, Wytheville, Va	25,000
Transferred to U. S. F. C. station, Washington, D. C	30,000
Total	207,000
Fry.	
From Central Station (eggs furnished by Northville Station):	
To applicants in Pennsylvania	3,000
To applicants in West Virginia	4,000
Island Run, near Wilsonia, W. Va	9,000
Patap co River, near Woodstock, Md	5,000
Total	21,000
One year old.	
From Northville Station:	
Tippecanoe River, near Monticello, Ind	500
To applicants in Indiana	225
Nolan River, near Elizabethtown, Ky	500
Paw Paw River, near Lawton, Mich	250
Pine Creek, near Kalamazoo, Mich	200
Harrison's Branch of Tobacco River, near Hatton, Mich	250
South Branch of Tobacco River, near Farwell, Mich	250
Chippewa Creek, near Chippewa, Mich	250
Kinney Creek, near Baldwin, Mich	250
Sabile River, near Manistee Junction, Mich	1,000
Ramsey's Creek, near Jackson, Mich	200
Michigan State fish commission	3,000
To applicants in Michigan	450
Cold Creek, near Castalia, Ohio	3,000
Rockwell Springs, near Castalia, Ohio	2,000
Ohio State fish commission	1,000
To applicants in Ohio	500
From Wytheville Station:	
To applicants in Virginia	500
From Central Station (product of Wytheville Station):	
To applicants in Tennessee	50
To applicants in Delaware	75
Total	14,450
Losses (one year old).	
In transit	50
At Central Station	60

Statement of the distribution of lake trout eggs, fry, and 1-year-old fish, for the year ending June 30, 1889.

Disposition.	Number.
Eggs.	
From Northville station:	
Iowa State fish commission	50,000
Nebraska State fish commission	100,000
Nevada State fish commission	30,000
New Hampshire State fish commission	100,000
Vermont State fish commission	100,000
Wyoming State fish commission	200,000
C. F. Stoddard, Cambridge, N. Y	25,000
E. Cházari, City of Mexico, for the Republic of Mexico	50,000
Transferred to U. S. F. C. station, Duluth, Minn	1,000,000
Transferred to U. S. F. C. station, Washington, D. C	40,000
Transferred to U. S. F. C. station, Cold Spring Harbor, N. Y	500,000
Transferred to U. S. F. C. station, Bucksport, Me	2,000
Total	2,197,000
Fry.	
From Alpena Station:	
Long Lake near Alpena, Mich	80,000
From Duluth Station (eggs furnished by Northville Station):	
Lake Superior, off mouth of Lester River, Minnesota	985,000
From Central Station (eggs furnished by Northville Station):	
Applicants in Pennsylvania	11,000
Allegheny Creek, near Gibraltar, Pa	10,000
Mill Creek, near Gibraltar, Pa	10,000
Seidel's Creek, near Gibraltar, Pa	5,000
From Cold Spring Harbor Station:*	
Lake Ronkonkoma, Long Island, N. Y	180,000
Great Pond, Long Island, N. Y	100,000
Lake Glenida, Putnam County, N. Y	50,000
Racquette Lake, Hamilton County, N. Y	100,000
Total	1,531,000
One year old.	
From Northville Station:	
Lake Maxinkuckee, near Indianapolis, Ind	990
Crooked Lake, near Angola, Ind	4,760
Fox Lake, near Angola, Ind	2,700
Silver Lake, near Angola, Ind	1,985
Sylvan Lake, near Rome City, Ind	3,000
To applicants in Indiana	1,000
Black Walnut Lake, near Birmingham, Mich	1,500
To applicants in Michigan	400
Michigan State fish commission	12,125
From Wytheville Station:	
Salt Ponds, near Eggleston, Va	575
Total	29,035

SUMMARY.

Station at which produced.	Eggs.	Fry.	One year old.
Northville	2,197,000		28,525
Alpena		80,000	
Duluth		985,000	
Central Station		36,000	
Cold Spring Harbor		430,000	
Wytheville			575
Total	2,197,000	1,531,000	29,100
Loss in transit			65

Statement of the distribution of sälbling eggs (received by international exchange from Berneuchen, Germany) during the year ending June 30, 1889.

Disposition.	Number.
From Berneuchen:	
To U. S. F. C. station, Duluth, Minn	9,000

Statement of the distribution of whitefish eggs and fry for the year ending June 30, 1889.

Disposition.	Number.
Eggs.	
From Northville Station:	
Delaware fish commission	1,000,000
Wisconsin fish commission	5,000,000
Midland Counties Fish-Cultural Association, Malvern Wells, England	150,000
Herr Von Behr, Schmoldow, Germany	100,000
Transferred to U. S. F. C. Car No. 3 for hatching and deposit in public waters in Idaho, Washington, and Oregon	5,000,000
From Alpena Station:	
Transferred to U. S. F. C. station at Duluth, Minn	5,000,000
Transferred to U. S. F. C. station at Washington, D. C	5,000,000
From Sandusky Station:	
Pennsylvania fish commission	24,400,000
Transferred to U. S. F. C. station at Duluth, Minn	9,000,000
Total	54,650,000
Fry.	
From Alpena Station:	
Planted in Lake Huron	20,320,000
Planted in Lake Michigan	3,000,000
From Sandusky Station:	
Planted in Lake Erie	40,700,000
From Duluth Station (eggs received from Alpena and Sandusky Stations):	
Planted in Lake Superior	8,000,000
From Central Station (eggs received from Alpena Station):	
Planted in Lake Ontario	4,595,000
By U. S. F. C. Car No. 3 (eggs received from Northville Station):	
Cœur d'Alene Lake, Idaho	1,950,000
Pend d'Oreille Lake, Idaho	1,300,000
Washington Lake, Washington	385,000
Camas Lake, Oregon	300,000
Klamath Lake, Oregon	400,000
Chetaw Lake, Oregon	85,000
Cullaby Lake, Oregon	100,000
Total	81,135,000

Statement of the deposits of shad fry in the public waters of the United States, during the season of 1889.

Date.	Point of deposit.	Stream.	River basin.	Number deposited.
May 23	Dighton, Mass	Taunton River	Narragansett Bay	1,747,000
15	Providence, R. I	Palmer River	..do	2,455,000
28	Warehouse Point, Conn	Connecticut River	North Atlantic Coast	1,803,000
17	Waterford, N. Y	Hudson River	Hudson River	1,700,000
17	Albany, N. Y	...do	...do	300,000
19	Troy, N. Y	...do	...do	580,000
27	West Point, N. Y	...do	...do	761,000
June 4	...do	...do	...do	1,095,000
7	...do	...do	..do	652,000
May 31	Newburgh, N. Y	...do	..do	805,000
15	Port Jervis, N. Y	Delaware River	Delaware Bay	792,000
June 11	Gloucester, N. J	...do	...do	1,904,000
May 21	Bridgeton, N. J	Cohansey River	...do	1,147,000
June 10	Lambertville, N. J	Delaware River	...do	970,000
11	...do	...do	...do	900,000
May 13	Delaware Water Gap, Pa	...do	...do	475,000
17	...do	...do	...do	743,000
18	...do	...do	...do	2,227,000
20	...do	...do	...do	760,000
28	...do	...do	...do	800,000
30	...do	...do	...do	800,000
17	Easton, Pa	...do	...do	750,000
21	...do	...do	...do	720,000
June 1	...do	...do	...do	720,000
3	...do	...do	...do	760,000
8	...do	...do	...do	800,000
4	Pond Eddy, Pa	...do	...do	760,000
6	...do	...do	...do	779,000
May 25	Lackawaxen, Pa	...do	...do	720,000
12	Wilmington, Del	Brandywine Creek	...do	760,000
15	...do	...do	...do	792,000
21	Middletown, Del	Appoquinnack Creek	...do	228,400
22	...do	...do	...do	212,976
21	Clayton, Del	Smyrna Creek	...do	228,450
22	...do	...do	...do	212,976
21	Cheswold, Del	Leipsic Creek	...do	285,500
22	...do	...do	...do	159,732
21	Dover, Del	Jones Creek	...do	285,500
22	...do	...do	...do	212,976
21	Felton, Del	Murderkill Creek	...do	428,250
22	...do	...do	...do	212,976
21	Milford, Del	Mispillion Creek	...do	285,500
22	...do	...do	...do	212,976
21	Ellendale, Del	Broadkill Creek	...do	228,400
22	Millsboro, Del	Indian River	...do	399,388
2	Seaford, Del	Nanticoke River	Chesapeake Bay	1,600,000
13	Queen Anne, Md	Tuckahoe River	...do	2,970,000
14	Salisbury, Md	Wicomico River	...do	2,925,000
6	Chestertown, Md	Chester River	...do	500,000
1	Elkton, Md	Elk River	...do	400,000
4	...do	...do	...do	764,000
7	...do	...do	...do	760,000
12	...do	...do	...do	700,000
13	...do	...do	...do	600,000
14	...do	...do	...do	700,000
18	...do	...do	...do	792,000
27	...do	...do	...do	520,000
1	North East, Md	North East River	...do	400,000
1	...do	...do	...do	214,000
3	...do	...do	...do	500,000
4	...do	...do	...do	764,000
7	...do	...do	...do	800,000
13	...do	...do	...do	882,000
14	...do	...do	...do	800,000
18	...do	...do	...do	1,325,000
Apr. 26	Battery Island, Md	Susquehanna River	...do	643,000
May 1	...do	...do	...do	512,000
4	...do	...do	...do	170,000
7	...do	...do	...do	600,000
28	...do	...do	...do	1,000,000
29	...do	...do	...do	345,000
June 1	...do	...do	...do	451,000
May 14	Fites Eddy, Pa	...do	...do	844,000
15	...do	...do	...do	800,000
17	Columbia, Pa	...do	...do	813,000
10	Peach Bottom, Pa	...do	...do	670,000
13	McCall's Ferry, Pa	...do	...do	844,000
13	Bush Station, Md	Bush River	...do	800,000
6	Gunpowder Station, Md	Gunpowder River	...do	600,000

Statement of the deposits of shad fry in the public waters of the United States, during the season of 1889—Continued.

Date.	Point of deposit.	Stream.	River basin.	Number deposited.
May 14	Gunpowder Station, Md	Gunpowder River	Chesapeake Bay	800,000
13	Relay House, Md	Patapsco River	...do	742,000
15	...do	...do	...do	701,000
17	...do	...do	...do	909,000
3	Laurel, Md	Patuxent River	...do	666,000
14	...do	...do	...do	699,000
Apr. 25	Washington, D. C	Carp Ponds	...do	408,000
27	...do	...do	...do	550,000
29	...do	...do	...do	430,000
30	...do	...do	...do	603,000
May 1	...do	...do	...do	925,000
2	...do	...do	...do	932,000
3	...do	...do	...do	400,000
5	Little Falls, Md	Potomac River	...do	807,000
20	Fort Washington, Md	...do	...do	2,994,000
13	Mathias Point, Va	...do	...do	713,000
4	Occoquan, Va	Occoquan Creek	...do	500,000
4	Quantico, Va	Chappawansic Creek	...do	750,000
12	Evington, Va	Otter River	...do	750,000
13	Catletts, Va	Cedar Run	...do	783,000
13	Bristoe, Va	Broad Run	...do	784,000
15	Tye River, Va	Tye River	...do	765,000
14	Rapidan, Va	Rapidan River	...do	629,000
14	Milford, Va	Mattaponi River	...do	743,000
17	Penola, Va	...do	...do	659,000
15	Taylorsville, Va	Little River	...do	399,000
15	Rockfish, Va	Rockfish River	...do	659,000
16	Freestone, Va	Neabsco Creek	...do	932,000
18	Bellfield, Va	Meherrin River	...do	920,000
16	Fredericksburgh, Va	Rappahannock River	...do	763,000
18	...do	...do	...do	902,000
16	Stony Creek, Va	Stony Creek River	South Atlantic coast	743,000
17	Newport, N. C	Newport River	...do	681,000
Apr. 28	Columbia, S. C	Congaree River	...do	1,000,000
29	Augusta, Ga	Savannah River	...do	1,000,000
May 14	Macon, Ga	Ocmulgee River	...do	390,000
Apr. 29	Butler, Ga	Big White Water Creek	Gulf of Mexico	600,000
30	Reynolds, Ga	Flint River	...do	794,000
May 14	Ochlochnee, Ga	Ocklockonee River	...do	400,000
14	Boston, Ga	Aucilla River	...do	300,000
14	Quitman, Ga	Withlacoochee River	...do	300,000
14	Allapaha, Ga	Allapaha River	...do	400,000
10	Bolton, Ga	Chattahoochee River	...do	900,000
11	Montgomery, Ala	Alabama River	...do	500,000
11	Hattiesburgh, Miss	Leaf River	...do	825,000
11	Enterprise, Miss	Chickasawha River	...do	825,000
	Total			96,454,000

Summary of production and distribution of shad and shad eggs season of 1889.

	Fort Washington Station.	Central Station.	Battery Station.	Steamer Fish Hawk.	Total.	Grand total.
Eggs collected	*58, 233, 000	....	57, 809, 000	31, 396, 000	....	147, 438, 000
Disposition.						
Fry:						
Deposited in waters whence obtained	2, 994, 000	....	5, 260, 000	1, 904, 000	10, 158, 000	89, 322, 000
Deposited in other waters	....	23, 404, 000	34, 708, 000	21, 052, 000	79, 164, 000	
Eggs:						
Delivered to Car No. 2	....	3, 578, 000	....	....	3, 578, 000	12, 672, 000
Delivered to Car No. 3	....	7, 519, 000	1, 575, 000	....	9, 094, 000	
Fish lost in hatching	....	....	673, 000	....	673, 000	673, 000
Eggs lost:						
In shrinkage en route from Fort Washington to Central Station	7, 710, 000	....	....	....	7, 710, 000	44, 771, 000
In incubation	275, 000	12, 753, 000	15, 593, 000	8, 440, 000	37, 061, 000	
Total	10, 979, 000	47, 254, 000	57, 809, 000	31, 396, 000	....	147, 438, 000

*47,254,000 of these were transferred to Central Station for hatching.

Summary by river basins of shad fry distributed during 1889.

River basin.	No. of shad deposited.	No. of shad lost in transit.	Total.
Tributaries of Narragansett Bay	4, 202, 000	63, 000	4, 265, 000
Tributaries of North Atlantic coast	1, 803, 000	....	1, 803, 000
Hudson River and tributaries	5, 893, 000	313, 000	6, 206, 000
Delaware Bay and tributaries	22, 673, 000	256, 000	22, 929, 000
Chesapeake Bay and tributaries	52, 225, 000	1, 979, 000	54, 204, 000
Tributaries of South Atlantic coast	3, 814, 000	366, 000	4, 180, 000
Tributaries of Gulf of Mexico	5, 844, 000	2, 563, 000	8, 407, 000
Total	96, 454, 000	5, 540, 000	101, 994, 000

Statement of the deposit of English sole during the year ending June 30, 1889.

Disposition.	Yearlings.
From Wood's Holl Station:	
Deposited in Vineyard Sound, near Wood's Holl Station	28

Statement of the deposits of codfish fry in the Atlantic Ocean, season of 1888–'89.

Disposition.	Number.
From Gloucester Station:	
Planted off the coast of Massachusetts	11, 011, 000
Wood's Holl Station:	
Planted off the coast of Massachusetts	8, 137, 000
Total	19, 148, 000

Statement of the deposit of pollock fry in the Atlantic Ocean, season of 1888–89.

	Fry.
From Gloucester Station:	
Planted off the coast of Massachusetts	7,258,000

Statement of the distribution of mackerel during the year ending June 30, 1889.

Disposition.	Fry.
From Wood's Holl Station:	
Deposited in Vineyard Sound off Wood's Holl Station, Mass	185,000

Statement of the distribution of scup during the year ending June 30, 1889.

Disposition.	Fry.
From Wood's Holl Station:	
Deposited in Vineyard Sound off Wood's Holl Station, Mass	30,000

Statement of the distribution of sheepshead during the year ending June 30, 1889.

Disposition.	Fry.
Hatched on steamer *Fish Hawk*:	
Deposited in San Carlos Bay, Florida	14,000,000

Statement of the distribution of red-eye perch during the year ending June 30, 1889.

Disposition.	Yearlings.
From Wytheville Station:	
Yadkin River near Salem, N.C	500
Applicants in North Carolina	820
Cow Pasture River near Millboro, Va	980
Applicants in Virginia	2,130
From Central Station; product of Wytheville Station:	
Alabama State Fair Association at Opelika	50
Applicants in Georgia	100
Antietam Creek near Hagerstown, Md	500
Applicants in Massachusetts	100
Applicants in New York	300
Applicants in Virginia	50
Max von dem Borne, Berneuchen, Germany	100
Total	5,630

Statement of the distribution of sea bass during the year ending June 30, 1889.

Disposition.	Fry.
From Wood's Holl Station:	
Deposited in Vineyard Sound off Wood's Holl Station	1,025,000

Statement of the distribution of pike-perch fry, season of 1889.

Date.	Point of deposit.	Waters stocked.	Number.
May 21	Near Duluth, Minn	Lake Superior	3,000,000
Apr. 30	Decatur, Ill	Sangamon River	200,000
May 1	Barclay, Ill	...do	200,000
Apr. 30	Kankakee, Ill	Kankakee River	6,000,000
May 1	Springfield, Ill	Clear Lake	1,000,000
1	Lanesville, Ill	Lake Whittimore	1,000,000
1	Railroad crossing, Cass County, Ill	Lake Henderson	100,000
1	St. Mary's, Ill	Embarras River	100,000
1	Olney, Ill	Fox Lake	100,000
1	Martinsville, Ill	Lake Delasmutt	100,000
1	Meredosia, Ill	Illinois River	1,300,000
1	Quincy, Ill	Mississippi River	1,300,000
4	Near Bellefontaine, Ohio	Rush Creek	400,000
4	...do	Silver Lake	400,000
4	...do	Twin Lakes	400,000
4	...do	Doup Lake	400,000
4	...do	McMillan's Lake	400,000
4	West Liberty, Ohio	Mud River	1,600,000
4	Pickway, Ohio	Big Miami River	1,600,000
4	...do	Pickway Ponds	1,300,000
4	Xenia, Ohio	Little Miami River	2,000,000
4	Columbus, Ohio	Scioto River	2,200,000
4	Newark, Ohio	Licking River	1,000,000
4	Dresden Junction, Ohio	Muskingum River	1,600,000
4	Coshocton, Ohio	Tuscarawas River	1,600,000
4	Newcomerstown, Ohio	...do	1,200,000
8	State Fish commission of Ohio	Streams in Ohio	10,400,000
9	Callicoon, N. Y	Delaware River	1,450,000
9	Port Jarvis, N. Y	...do	1,450,000
9	Lackawaxen, Pa	...do	870,000
9	Easton, Pa	...do	1,160,000
9	Reading, Pa	Maiden's Creek	1,160,000
9	Millerstown, Pa	Juniata River	580,000
9	Thompsontown, Pa	...do	290,000
9	Port Royal, Pa	...do	290,000
9	Mifflin, Pa	...do	290,000
9	Lewistown, Pa	...do	290,000
9	Ryde, Pa	...do	145,000
9	Hollidaysburg, Pa	...do	290,000
9	Spruce Creek, Pa	Spruce Creek	290,000
9	Harrisburg, Pa	Susquehanna River	435,000
	Total		50,190,000

Produced by Duluth Station	3,000,000
Produced by Sandusky Station	47,190,000

Statement of the distribution of tench from Central Station (product of carp ponds) for the year ending June 30, 1889.

Disposition.	Yearlings.
Alabama State Fair Association at Opelika	25
Augusta National Exposition at Augusta, Ga	25
Applicants in Georgia	100
Applicants in Indiana	40
Applicants in Kansas	40
Monocacy River, near Frederick Junction, Md	1,000
Applicants in Pennsylvania	100
E. Chazari, City of Mexico, for the Mexican Republic	200
Total	1,530

Statement of the distribution of goldfish from Central and Wytheville Stations, from July 1, 1888 to June 30, 1889.

State.	No. of applicants.	No. of fish.	State.	No. of applicants.	No. of fish.
Alabama	12	110	Missouri	2	12
Arkansas	1	6	Mississippi	5	30
Connecticut	2	10	Montana Territory	1	3
Dakota Territory	3	112	Nebraska	1	25
Delaware	2	16	New Jersey	10	60
District of Columbia	731	3, 626	New York	8	46
Florida	5	34	North Carolina	24	174
Georgia	35	184	Ohio	42	287
Idaho Territory	2	10	Oregon	4	24
Illinois	4	120	Pennsylvania	49	272
Indiana	10	152	South Carolina	9	146
Iowa	10	64	Tennessee	90	540
Kansas	5	24	Texas	9	66
Kentucky	8	90	Utah Territory	4	47
Louisiana	22	138	Virginia	372	2, 280
Maryland	44	258	West Virginia	2	56
Massachusetts	6	36	Mexico	1	100
Michigan	2	12			
Minnesota	8	440	Total	1, 545	9, 610

Statement of carp distributed to private applicants from Nov. 7, 1888, to March 6, 1889.

Date.	Destination.	Point of distribution.	No. of counties supplied.	No. of applicants supplied.	No. of fish distributed.
1888.					
Nov. 27	Alabama	Atlanta, Ga	27	63	1, 440
9	Arizona	Kansas City, Mo	4	31	1, 080
9	Arkansas	St. Louis, Mo	14	27	520
15	California	Ogden, Utah	3	3	60
9	Colorado	Kansas City, Mo	9	19	480
12	Connecticut	Jersey City, N. J	4	8	160
Oct. 6	District of Columbia	Washington, D. C	....	2	220
Nov. 19	Dakota	St. Paul, Minn	13	22	520
Dec. 4	Delaware	Washington, D. C	2	2	1, 020
Nov. 27	Georgia	Atlanta, Ga	50	80	4, 810
15	Idaho	Salt Lake City, Utah	6	22	440
21	Illinois	Chicago and Quincy, Ill	40	68	36, 290
7	Indiana	Indianapolis, Ind	42	87	3, 790
9	Indian Territory	St. Louis, Mo	4	7	2, 120
14	Iowa	Des Moines, Iowa	45	72	5, 605
12	Kansas	Kansas City, Mo	72	279	6, 790
16	Kentucky	Indianapolis, Ind	19	32	870
12	Maine	Jersey City, N. J	5	7	140
Dec. 4	Maryland	Washington, D. C	13	28	650
Nov. 12	Massachusetts	Jersey City, N. J	4	6	630
21	Michigan	Detroit, Mich	25	35	680
19	Minnesota	St. Paul, Minn	10	10	5, 180
12	Missouri	Kansas City, Mo	11	24	640
12	Nebraska	Omaha, Nebr	17	27	540
15	Nevada	Ogden, Utah	1	1	20
12	New Hampshire	Jersey City, N. J	5	5	130
12	New Jersey	...do	9	18	360
Dec. 18	North Carolina	Raleigh, N. C	45	83	1, 790
Nov. 12	New York	Jersey City, N. J	43	120	11, 740
9	New Mexico	El Paso, Tex	11	20	1, 440
5	Ohio	Columbus and Cincinnati	43	80	3, 070
21	Pennsylvania	Washington, D. C	48	165	4, 560
12	Rhode Island	Jersey City, N. J	1	1	20
27	South Carolina	Augusta, Ga	18	25	530
Dec. 12	Tennessee	Chattanooga, Tenn	31	68	1, 300
Nov. 15	Utah	Ogden and Salt Lake City, Utah	21	675	17, 400
12	Vermont	Jersey City, N. J	2	3	60
20 Dec. 3	Virginia	Washington, D. C, and Wytheville, Va.	67	299	7, 010
3	West Virginia	Washington, D. C	11	24	560
Nov. 19	Wisconsin	St. Paul, Minn	18	21	720
14	Wyoming	Ogden, Utah	1	1	60
1889.					
Feb. 13	Florida	Jacksonville, Fla	13	19	420
Jan. 17	Louisiana	New Orleans, La	11	22	460
18	Mississippi	Jackson, Miss	20	42	822
18	Montana	Helena, Mont	10	33	670
Mar. 6	Oregon	Portland, Oreg	3	12	280
Jan. 9	Texas	Dallas, Tex	35	54	1, 460
Mar. 6	Washington	Tacoma, Wash	11	21	420
Jan. 22	Canada	Detroit, Mich	2	2	70
8	Mexico	Laredo, Tex	1	1	5, 000
	Total	....	920	2, 776	135, 047

Deposits of carp in the public waters of the United States from November 7, 1888, to March 22, 1889.

Date.	State to which destined.	Point of deposit.	Waters stocked.	No. of fish.
1888.				
Nov. 19	Dakota	Near Mitchell	Dakota River	500
19	....do	Near Mandan	Cannon Ball River	500
19	....do	....do	Big Heart River	500
19	....do	....do	Little Heart River	500
19	....do	....do	Knife River	500
Dec. 15	Georgia	Near Augusta	Savannah River	1,500
Nov. 28	....do	Near Covington	Yellow River	1,000
7	Indiana	Near Knightstown	Branch of Blue River	200
12	Kansas	Near Kansas City	Kansas River	1,000
Dec. 20	North Carolina	Near Salisbury	Yadkin River	2,455
21	....do	Near Pedee Station	Pedee River	2,430
Nov. 14	Ohio	Near Zanesville	Muskingum River	1,500
15	....do	Near Columbus	Scioto River	10,000
17	....do	Near Cincinnati	Ohio River	900
Dec. 14	Tennessee	Near Springfield	Red River	5,000
1889.				
Jan. 16	Louisiana	Near New Orleans	Mississippi River	200
9	Maryland	Near Frederick Junction	Monocacy River	4,000
Feb. 13	Florida	Near Palmer	Wells Lake	1,600
Mar. 22	Virginia	Near Wytheville	Cripple Creek	1,070
	Total			35,355

SUMMARY.

States supplied		38
Territories supplied		10
Foreign countries supplied		2
Public streams stocked		19
Counties supplied		920
Applicants supplied		2,776
Total number of fish:		
To applicants	135,047	
To public waters	35,355	
		170,402
Loss in transit		38,841
Total furnished for distribution		209,243
Produced at carp ponds, Washington, D. C		190,928
Produced at Wytheville Station		18,315

*Statement of the distribution of breeding lobsters for the year ending June 30, 1889.**

Disposition.	Males.	Females.
Collected at Wood's Holl Station and transported and deposited by U. S. Fish Commission car No. 3:		
Pacific Ocean, off Cape Disappointment, Wash	25	63
Pacific Ocean, off Shoalwater Bay, Wash	7	15
Puget Sound, off Scow Bay, Wash	8	16
Puget Sound, off Hudson Point, Wash	8	17
Puget Sound, off Wilson's Point, Wash	24	50
Shipped via steamer from New York City:		
Gulf of Mexico, off Galveston, Texas	50	50
Total	122	211

* Besides this distribution of adults, 1,574,000 young, hatched at Wood's Holl, Massachusetts, were deposited in Vineyard Sound.

Distribution of indigenous fishes of the Mississippi Valley from Quincy, Illinois—Season of 1888.

Point of deposit.	Stream.	Catfish.	Buffalo.	Crappie.	White bass.	Black bass.	Sunfish.	Pickerel.	White perch.	Wall-eye pike.	Carp sucker.	Total No. planted.
Zanesville, Ohio	Muskingum River	4,235	1,325	390	475	500	375	300	275	100		7,975
Edinburgh, Ind	Blue River	725	825	850	325	225	250	200	200	200		3,800
Danville, Ill	Vermillion River	1,000	300		1,500	1,000	170	500		500	10	4,980
Dixon, Ill	Rock River	900	100	1,000	900	800				250		3,950
Belleville, Ill	City reservoir	50	50	100	50	50	50	50				400
Do	Gilmore Lake	100		200	70	100	80	100	50			700
New Athens, Ill	Perkins Lake	75	75	500	200	150		300	100			1,400
Duquoin, Ill	Cherry Lake	200		150	200	150		100	50	150		1,000
Macomb, Ill	Lake at Macomb	100	20	150	100	50	50	50				520
Galesburgh, Ill	Lake George	400	150	500	400	400	150	300	200	200		2,700
Do	C., B. and Q. R. R. Co.'s ponds	250	150	400	200	250	88	300	200	150		1,988
Aurora, Ill	Fox River	200	150	300	1,000	800	125	150		50		2,775
Kankakee, Ill	Kankakee River	600	300		600	600	150	300		300	150	3,000
McHenry, Ill	Fox Lake	385	275	850	300	500	200	500	300	590		3,900
Gladstone, Ill	Crystal Lake	575	425	750	175	125	200	100	150	100		2,600
Macoupin, Ill	Beaver Dam Lake	500	480	1,000		1,500		1,000				4,480
Chicago, Ill	Ponds in Humboldt Park	300	150	600	150	150						1,350
Do	Ponds in Garfield Park	300	150	600	150	150						1,350
Do	Ponds in Douglass Park	400	260	800	200	190						1,850
Berlin, Ill	Wabash Railroad Company's ponds	400	450	300	150	200	100	100	100	100		1,900
Lanesville, Ill	Lake Whittimore	390	475	300	135	200	100	100	100	100		1,900
Mitchell, Ill	Long Lake	100	300	100		100					100	700
Shelbyville, Ill	Reno Lake	400	300	400	200	200	100	100	100	100	100	2,000
Charleston, Ill	Embarras River	400	150	375	275	200		100	200		100	1,800
Bowling Green, Ky	Barren River	675	650	850	275	125	150	175	150	150		3,200
Munfordville, Ky	Green River	800	725	800	350	375	200	200	200	200		3,850
Crisp, Mo	Lake McDonald	1,200	75	1,000	1,400	1,300	50	250		150		5,425
Doniphan, Mo	Current River	500	250	500	1,000	1,500	250	500		500		5,000
Helton, Mo	St. L., K. and N. W. R. R. Co.'s ponds	125		250	250	250	125	125		125		1,250
Ashburn, Mo	do	125		250	250	250	125	125		125		1,250
Marceline, Mo	Lake near Marceline	100	50	100	50	150	50					500
Hurricane, Mo	King's Lake	125		250	250	250	125	125		125		1,250
Rearlings, Mo	Krugle Lake	125		250	250	250	125	125		125		1,250
Lake Geneva, Wis	Geneva Lake	1,980	500		2,400	2,850		500		980		9,210
Nebraska City, Nebr	Lake near Nebraska City	50		50	75		25			30		230
Seward, Nebr	Blue River	370	375	375	170	200	150	100		100		1,840
Ravenna, Nebr	Beaver Creek	370	375	375	170	200	125	100	100	100		1,915
Norfolk, Nebr	Elkhorn River	200	100	250	300	400		200				5,250
Stuart, Nebr	do	450	400	850	600	900		600				
Twin Bridges, Del	Brandywine Creek			3	7	97		36	10			153
Total		20,180	10,360	16,768	15,552	17,687	3,688	7,811	2,485	5,600	460	100,591

4.—REPORT UPON THE INVESTIGATIONS OF THE U. S. FISH COMMISSION STEAMER ALBATROSS FOR THE YEAR ENDING JUNE 30, 1889.

By Lieut. Commander Z. L. TANNER, U. S. N., Commanding.

[With plates L, LI, and LII.]

INVESTIGATIONS ON THE ALASKAN COAST.

San Francisco to Departure Bay.—The steamer *Albatross* left San Francisco at 9:30 a. m. July 4, 1888, for Alaska, the object of the expedition being to explore the waters adjacent to the Aleutian Islands and the Alaska Peninsula, for the purpose of ascertaining the character and extent of the cod and halibut fishing grounds, and of obtaining all possible information regarding the fishing interests and resources of that region.

We had on board 30 lobsters, recently received from Wood's Holl, Massachusetts, which were to be deposited at some point on the California coast north of San Francisco. It was decided, on the recommendation of Prof. George Davidson, to plant them near Trinidad, as in his opinion the natural conditions of the New England coast, the home of the lobster, were more fully realized at that point than anywhere else on the northern California coast. The shores are bold and rocky, the sea-bottom ledges covered with kelp, alternating with sandy patches, and the water pure. The lobsters were placed in tubs of salt water and covered with kelp to exclude the light, the water being changed at frequent intervals. At 7:30 p. m. July 5 they were deposited in 13 fathoms, 1½ miles S. ¾ W., magnetic, from Trinidad light-house, all in good condition except one. The temperature was 50° F., about the same as the waters of the northern New England coast during July.

NOTE.—All bearings are true unless otherwise stated.

We encountered strong head winds and heavy seas along the coast, and on arriving in the Straits of Fuca found our coal supply so nearly exhausted that we considered it prudent to call at Esquimalt, where we were promptly supplied by Mr. James H. Innes, in charge of Her British Majesty's dockyard. We left Esquimalt at meridian, July 9, and arrived at Departure Bay, British Columbia, at 7:50 p. m.; went to the coal wharf at 6:45 the following morning, and finished coaling at 4:15 p. m. on the 11th, having taken on board 185.5 tons.

Departure Bay to Unalaska.—We left the wharf an hour later and proceeded to sea, anchoring for the night in Tribune Bay. Getting under way at 3:30 the following morning, we passed Seymour Narrows at 8:35, just as the tide was beginning to ebb, which caused strong eddies and whirls, but the passage was made without difficulty.

We learned in Departure Bay that clams were plentiful at Alert Bay, where they had been canned extensively; so, wishing to procure some for bait, we called there, but learned that they could be had more plentifully at Fort Rupert. We then went to the last-named place, where we anchored at 6:55 p. m. A large party was sent out in the morning at low tide, and gathered about 4 barrels, two species being represented, *Schizothærus nuttalli*, and the small round clam, *Saxidomus nuttalli*, both excellent for table use. About half of them were "shucked" and salted for bait, a bushel or more were placed in the cold room at a temperature of 40°, and the remainder packed in barrels, through which sea water was pumped at intervals.

We left Fort Rupert at 11:30 a. m. July 13, and, passing through the Goleta Channel, were in the open sea, well clear of the land, before dark. The passage was made under one boiler, with reduced grate surface, as the expenditure of coal was limited to 10 tons per day.

Gentle to moderate winds from SE., S., and SW., with much overcast, misty, and foggy weather, were encountered. At 6:15 a. m. on the 19th we sounded in 2,550 fathoms brown ooze, latitude 52° 15′ 00″ N., longitude 156° 37′ 00″ W. This was the first of a series of soundings extending N. 88° W., 390 miles, and made to further develop a remarkable submarine depression, discovered by the U. S. S. *Tuscarora*, to the southward of the Aleutian Islands. The soundings of that vessel revealed a depression simply, but geologists predicted the existence of a submarine trough running parallel to the islands, and extending probably their whole length, to the *Tuscarora's* sounding of 4,037 fathoms off Attu. The *Albatross* soundings, supplementing those of Captain Belknap, developed this predicted trough to the extent of 400 miles. The direction was S. 65° W. and N. 65° E., nearly parallel with the islands, the center being 60 miles from the Shumagins and 100 miles from the SW. extremity of Unalaska. It is about 30 miles in width, between the 3,000-fathom lines, with a maximum depth of 3,820 fathoms, in latitude 52° 20′ 00″ N., longitude 165° 00′ 00″ W. It is to be regretted that the *Albatross*, which is eminently fitted for the purpose,

was unable to pursue the explorations further, but our work called us in another direction.

Unalaska to the Shumagin Islands.—Having crossed the trough and reached the normal depth west of it, we ran a line to the island of Unalaska, in the vicinity of Kiliuliuk Bay, developed the contour of the slope, and located ourselves with reference to the land, which was visible at times during the afternoon, when the fog lifted for a moment. At 5:30 we sounded in 28 fathoms off the bay above mentioned, then stood off shore, sounding at intervals. Trial lines were put over at several stations inside of the 100-fathom line, cod (*Gadus morrhua*) being taken at every station, and halibut (*Hippoglossus vulgaris*) at most of them—good fish, but averaging smaller than on the Atlantic coast.

The direction of the offshore line was N. 60° E., with depths of 55, 58, 83, and 174 fathoms, the latter at 20 miles from the starting point and 16 miles from Cape Prominence, the nearest land.

Having reached the 100-fathom line, we developed it for 95 miles in a northeasterly direction, to latitude 53° 42′ 00″ N., longitude 163° 58′ 00″ W., thence N. 22° E. 30 miles, sounding at intervals of 10 miles in 43, 45, and 45 fathoms, to a point S. 68° E., 34 miles from Seal Cape, passing 6 miles inside of a reported bank in 54° 00′ 00″ N. and 163° 33′ 00″ W. We intended to pass over the position, and supposed we had done so until our work was verified by a subsequent landfall. Later soundings seemed to indicate its location about 18 miles to the northward and eastward, where we found 25 fathoms. Trial lines were put over at station 1166 in 45 fathoms, fine gray sand, cod and halibut taking the bait freely.

Turning in shore we ran a line N. 75° W. 60 miles to a point S. 57° W., 8 miles from northwest Cape of Unimak, the northern entrance, to a pass of that name. The depth increased to 56 fathoms, 9 miles to the eastward of Seal Cape; 30 fathoms were found off Scotch Cap, and 80 fathoms at the end of the line.

We took our departure from the land off Kiliuliuk Bay at 6 p. m. July 21, and passed Scotch Cap at 3:43 a. m. on the 23d. As we had been enveloped in a dense fog during that time, our intermediate positions depended upon dead reckoning, but the greatest error did not probably exceed 4 miles.

A line was run from the above position S. 70° W. 23 miles, passing within 3 miles of the north head of Akun, at which distance it was sighted. The fog became lighter as we approached the islands, and after passing the head it was comparatively clear. The volcano of Akutan, 3,332 feet in height, became prominent as we approached the island of that name, although the summit was enveloped in fog. The whole visible portion of the island was covered with a luxuriant growth of grass, which could be seen surrounding great patches of snow still remaining in the gorges at an elevation of 1,000 feet or more, but there was not a tree of any kind to be seen. Two hauls of the

trawl were made off the northern extremity of Akutan in 72 and 86 fathoms, a great variety of specimens being taken. We then laid a course for Cape Cheerful, about S. 55° W., 24 miles distant. It was not visible until we were nearly up with Kalekhta Point, when it came out of the fog with such remarkable distinctness that it appeared close at hand in comparison with Kalekhta, not one-third the distance from us, but just visible through the mist. Appearances were so deceptive that it was only after cross bearings had been taken that we could convince ourselves that we were not several miles out of position.

Priest Rock, near Kalekhta Point, is nearly as high as the point itself, is very conspicuous and an unmistakable landmark when open of the point, but in approaching from the northward it does not begin to open until it bears about S. 67° E. Needle Rock, lying off the NW. extremity of Amaknak Island, near Ulakhta Head, is a small pinnacle which has been mistaken for Priest Rock when the latter was obscured by fog or mist, and has led vessels to the westward of the island into Captain's Bay instead of Iliuliuk, the port to which they were bound.

It may be said that cross bearings would make such a mistake impossible, but it too often happens in this region that anchorage must be made on a momentary view of one point only. Priest Rock once recognized there should be little difficulty in reaching Ulalashka, as a direct course leads to the outer harbor.

We anchored in the inner harbor of Iliuliuk at 3:15 p. m., entering without the least difficulty, the channel having been buoyed by the Alaska Commercial Company. The steamer *St. Paul*, belonging to the company, was at the wharf, preparing for a trip to the Seal Islands, and at the mooring buoy was the schooner *Angel Dolly*, with a cargo of walrus hides which she took in Moller Bay. I called upon the company's agent, Mr. Rudolph Neumann, immediately after we anchored, and ascertained that provision had been made to supply us with 100 tons of coal, which insured a fair season's work at least.

We have used Baird's bronze reel on the Sigsbee deep-sea sounding machine during the past year with great satisfaction, and every confidence in its ability to resist the crushing strains likely to be brought upon it by the exigencies of the service. We took some deep casts en route to the Pacific, and on one occasion reeled back a 60-pound sinker from a depth of over 2,000 fathoms, without its showing the slightest indication of weakness. On our arrival in San Francisco it was carefully calipered and found to be true, but after taking a sounding of 3,820 fathoms, on the evening of July 20, slack turns were detected and it was observed to be out of true, so much so, in fact, that we found it necessary to condemn it and to transfer the wire, such as was not spoiled by kinking, to a spare steel reel which we had in reserve.

The *St. Paul* left the wharf at 2:30 p. m. July 25, the *Albatross* taking her place an hour later. We commenced coaling the following morning and finished at 4:30 p. m. July 27, having taken on board

$113\frac{2171}{2240}$ tons, for which we receipted to the agent of the Alaska Commercial Company.

The naturalists were actively employed during our stay in port, adding materially to the collection of fishes and invertebrates. Attention was given to the birds of the island, and botanical collections were also made. Fog and rain prevailed, with intervals of partially clear, pleasant weather during our stay in port.

We left Iliuliuk at 9 a. m. July 28, after several hours' detention by a dense fog, which, however, had begun to lift at intervals, enabling us to see land at a distance of half a mile. Rounding Kalekhta Point, we stood for the southwest extremity of Unalga Island, and through the pass of that name, which is to be preferred to all others for a steamer bound to or from Unalashka, particularly in thick weather. The distance through is short and there are no hidden dangers, the rocks lining the shore on either side being close to the land and above water. The tide rushes through the Narrows with great force, causing heavy rips and at times overfalls, but it was quite smooth when we passed out, near high water. A vessel bound in would make the Signals, Egg Island, and the Old Man, lying off Cape Burka, all of which can be approached with comparative safety, the distance from the latter to the southeast extremity of Unalga Island not exceeding 4 miles. Once in the pass, a vessel has only to keep Unalga in sight until passing its southwest end, when it is but 2 miles to Erskine Point and about $3\frac{1}{2}$ miles to Kalekhta Point.

There is a rock off Erskine Point, which in thick weather might be mistaken for Priest Rock, but it may be recognized by another one between it and the point, having a flat top and showing smallest at the base. In approaching Kalekhta Point Priest Rock will begin to open out at WSW. $\frac{1}{4}$ W. (magnetic).

A full-powered steamer may use this pass at any stage of the tide, if time is an object, but under ordinary circumstances it would be advisable to enter it near slack water. It is not intended to include sailing directions for the Aleutian Islands in this report, and my only excuse for describing this pass so much in detail is that there is no published information concerning it, so far as I know, and it would naturally be avoided by a stranger unless he had some such information as I have given.

We found 30 fathoms at the southern entrance of the pass, in mid channel, and 36 fathoms 2 miles north of Old Man Island. The weather partially cleared as we entered the Pacific, enabling us to locate our stations by bearings of land during the afternoon.

A line of soundings S. 85° E., 36 miles, was run from the above position, the depth increasing to 57 fathoms. The trawl was lowered at the second and fourth stations: No. 2843, 45 fathoms, black sand, stones, and pebbles, and No. 2844, in 51 fathoms, gray sand. A large number and great variety of specimens were taken, showing a rich fauna and

live bottom. Trial lines were put over at the last station, taking halibut and cod, the former being more plentiful.

We then ran N. 56° E., 10 miles, and sounded in 59 fathoms, intending to take a departure for an offshore line, but the fog having shut in we anchored until 9 p. m., when it lifted for a moment and we found that Sea Lion Island bore N. 11° E. From this point we ran a line S. 75° E., 45 miles, sounding at intervals of about 10 miles, with 61 fathoms at the first station, then 43 fathoms, and at the end of the line, 7 miles further, 342 fathoms. We ran N. 11° E., 11 miles, and sounded in 62 fathoms, thence N. 75° W., 44 miles, to a point S. 75° E. from the northeast end of Ugomok, where we located the end of the line by cross-bearings.

The trawl was lowered at No. 2845 in 42 fathoms, coarse black sand, about 27 miles from Ugomok, developing a rich fauna, and the trial lines being put over cod were found abundantly. A comparison of this line with those north and south of it shows a less depth than previously found near shore, which seems to indicate a deposit along the line from the swift current of Unimak Pass. We found 71 fathoms in mid channel at the eastern entrance of the pass, and 63 fathoms S. 26° E., 1½ miles from Promontory Cape, from which point a line was run S. 80° E., 39 miles, the depth increasing to 72 fathoms, 25 miles from land, and shoaling to 33 fathoms at the end of the line. A line S. 25° W., 15 miles, showed a least depth of 25 fathoms 3 miles from the starting point, and 44 at the end. We then stood S. 85° E., in depths between 41 and 44 fathoms, and at 7 a. m., July 30, cast the trawl in the latter depth, fine gray sand, No. 2846, making a successful haul. The trial lines were put over and both cod and halibut taken.

We were under low speed during the night and early morning, waiting daylight, to approach reported dangers, the first, Lenard Rock, in latitude 54° 00′ 00″ N., longitude 163° 12′ 00″ W., and Anderson Rock, 54° 00′ 60″ N., 162° 47′ 00″ W., the latter showing above water. We intended passing over the positions given, and supposed we had done so until several hours later, when we found that we were about 12 miles N. 57° E. out of our reckoning. The low speed at which we ran all night, and the prevalence of a moderate southerly breeze, probably accounts for the unusual effect of current on our positions. At 7:45 a. m. we left the above station, and stood S. 7° E., 10 miles, finding bottom at 51 and 464 fathoms, the latter S. 52° E., 3 miles from the reported position of Anderson Rock. We saw no indication of shoal water, but that proves nothing, for we were enveloped in so dense a fog that we were unable to see more than one-quarter of a mile most of the time, and probably not to exceed one-half mile at any time while we were in the vicinity. The rock may be in or near the position assigned to it, but considering the influence of the current on our course from Promontory Cape, and the absence of any indication of shoal water in our last two soundings, it seems possible that the rock seen by Captain Anderson might have been one of the outer rocks on the Sannakh Reefs.

Leaving the region described we ran a line N. 48° E., 20 miles, sounding in 265, 60, and 47 fathoms, cod and halibut being taken at the last station, thence S. 50° E., 5½ miles, with bottom at 62 fathoms, and N. 50° E., 18 miles, sounding in 51, 37, and 38 fathoms, rocky bottom being found at the last two stations. We then ran 10½ miles N. 8° E., sounding in 80 and 82 fathoms, then N. 42° W., 3 miles, sounding in 56 fathoms, and finally S. 22° W., 6½ miles, where we found 81 fathoms. The last three courses were run in the vain endeavor to make Caton Island, in order to verify our position, and it was not until the last sounding that we realized how much we had overrun our reckoning. We were in the channel between the Sannakh and the Sandman group, and furthermore our sounding of 38 fathoms was on the cod bank of the Coast Survey chart No. 806, in latitude 53° 17′ 00″ N., longitude 161° 55′ 00″ W. As the fog was still very dense and night approaching, we took our departure from the position and ran a line N. 58° E., 62 miles, to a point S. 35° E., 5 miles from Sea Lion Rocks, Shumagin Group, the depths ranging from 81 to 45 fathoms. A successful haul of the trawl was made at the above station, in 48 fathoms, fine gray sand, No. 2847, and cod were taken in 52 fathoms, fine gray sand, 8 miles S. 58° W. This line of soundings increased the known area of cod-fishing grounds in the region of the Shumagins, and while it did not define the extent of the banks, it was a hopeful indication of what further investigation may reveal. It will be particularly valuable from its position, partially protected by adjacent land, and its proximity to safe and commodious harbors. Another successful haul of the trawl was made 10 miles N. 13° E., in 110 fathoms, green mud, No. 2848.

The weather partially cleared as we approached the land, enabling us to locate the last two positions by bearings, but the fog shut in again while the trawl was down, restricting our line of vision to one-fourth mile or less. It was impracticable to work near the land in such weather, as the expenditure of coal in groping about searching for land to locate ourselves was greater than we could afford, to say nothing of the danger attending it. The fog had been almost constant since our arrival among the islands, but we were in daily expectation of a change, so we concluded to run into Humboldt Harbor to wait for it.

Shumagin Islands to Mitrofania Bay.—Entering Popoff Strait we saw nothing until up within Barloff Bay, when the high and bold headland forming its southern shores emerged from the fog not more than 400 yards distant; thence to Egg Islands the course was clear, and after making them, the fog partially lifted ahead, Sand Point and Arch Rock being visible. Off the former was the fishing schooner *Arago*, from Bristol Bay, Bering Sea, with a fare of codfish bound into Humboldt Harbor. When up with Sand Point, the station of Lynde & Hough was seen, and at 12:34 p. m., July 31, we anchored off the wharf in 12 fathoms, the schooner anchoring near us.

Humboldt Harbor has been surveyed by the U. S. Coast and Geodetic

Survey (Chart No. 814). The holding ground is good, and it affords excellent protection from all winds. Messrs. Lynde & Hough, of San Francisco, have established a fishing and trading station on the north side of the bay, where they have all necessary appliances for salting salmon. There is a wharf at which ships' boats can land at any stage of the tide. Mr. O'Brien, the superintendent of the station, seemed much interested in the progress of our work, and the captain of the *Arago* gave us such information concerning the regions about the Shumagins and Sannakhs as he had gained by several years' fishing in their waters. His reasons for going to Bristol Bay were that the fish ran a little larger and the weather was much better, there being less fog and smoother water.

August came in with a dense fog which partially cleared towards noon, only to shut down thicker than ever for the remainder of the day. Our work, up to this time, was done without the services of a pilot, but it frequently resulted in the loss of time and expenditure of fuel, trying to recognize our landfalls through mist and fog where it was the exception to see more than a single point at a time, and that dimly, a condition of affairs requiring local knowledge. Fortunately Capt. Paul M. Pavloff, one of the best coast pilots in the Aleutians, arrived during the morning, and we lost no time in securing his services.

Preparations were made to get under way at 4 a. m. August 2, but the fog was so thick, and the rain pouring down so heavily, that we held on until 6:40, when the sun appearing through the mist enabled us to leave the harbor and steam through Popoff Strait. At 7:30 we cast the trawl in 69 fathoms, green mud, No. 2849, making a successful haul notwithstanding the rocky bottom, which tore the net badly. The fog settled again while the trawl was down, obscuring the land on every side, which, with the general aspect of the weather, was so unpromising that we thought it advisable to seek an anchorage. Steaming across the strait at 9:45 a. m. we anchored in Eagle Harbor. A vessel may anchor anywhere in the harbor in from 15 to 22 fathoms, and in the cove on the northern side she would find perfect protection from the sea, where she could haul out for repairs, fill her water casks, or gather driftwood on the beach. The south cove has a narrow tortuous entrance, too shoal for anything larger than a ship's boat at low water, but a vessel drawing 6 or 8 feet could be warped or towed in at high tide, and once inside would be as secure as in a dock.

The weather cleared toward midday, giving us the first distinct view of the Shumagins, among which we had been cruising. Being too late in the day to start on our contemplated line, we spent the afternoon in drying sails and various gear, sounding, setting a trawl line, and making general collections. Unfortunately the line was set on the bar at the mouth of the harbor in about 17 fathoms, mud. But the fact of taking cod and halibut under such unfavorable circumstances augurs well for the future success of the shore fisheries.

We were under way at 3:20 the following morning, and leaving the harbor steamed in the direction of Sea Lion Rocks until, at 4:55, we slowed the engines and swung ship under steam for compass errors, observing azimuths on every point. The evolution consumed an hour and fifteen minutes, after which we resumed our course.

At 6:35 we sounded, in 34 fathoms, broken shells, Sea Lion Rocks bearing N. 39° W., one-half mile. These rocks are about 100 feet high and can be safely approached within half a mile. They are the resort of sea lions and birds. From our position near the rocks we ran 9 miles N. 85° W., and sounded in 38 fathoms, then N. 60° W., 24 miles, sounding in 71 and 74 fathoms, the latter position being located by cross-bearings of the large and more important islands to the northward and westward. The weather was clear at this time, and we could see land at a great distance, particularly to the northward and westward, where the snow-capped peak of Pavloff's volcano was distinctly visible. Deer Island and most of the smaller islets and rocks of the Sandman group were in sight, and directly ahead of us was a small pinnacle-shaped island not more than 10 miles distant, far from its position on the chart. Changing the course a little, to bring it on the starboard bow, we steamed ahead a few miles, when breakers and, a moment later, rocks were reported on the port bow, still more out of position than the island.

At 11:34 we sounded in 31 fathoms, 7 miles S. 47° W. from the last station, then ran S. 26° W. 3.3 miles, and at 11:57 sounded in 43 fathoms, Low Rocks, bearing N. 66° 30′ W., distant 0.6 mile. Continuing on the same course we ran 0.6 mile to meridian, when we were in latitude 54° 44′ 00″ N., longitude 161° 27′ 30″ W. The latitude was by meridian altitude of the sun and the longitude by chronometer, forenoon observations, the position being entitled to the same credit usually accorded to sea observations. Another sounding was taken at 1:12 p. m. in 49 fathoms, S. 47° W., 10 miles from the last station. We then ran 20 miles S. 51° W., sounding in 75 and 63 fathoms. Hay Island was located by cross-bearings and found to be several miles out of place on the charts.

The following are the positions we assign to the rocks and islands mentioned above, based on cross-bearings and the noon position of the ship: Low Rocks, latitude 54° 45′ 00″ N., longitude 161° 28′ 00″ W.; Pinnacle Island, latitude 54° 45′ 00″ N., longitude 161° 35′ 00″ W.; Hay Island, latitude 54° 39′ 00″ N., longitude 161° 53′ 30″ W.

A dense fog set in at 3 p. m., again obscuring the land, making it impossible to sight the Sannakhs, and, as there was no immediate prospect of improvement of the weather, we stood off shore, S. 70° E., 6 miles, and sounded in 34 fathoms. The trial lines being put over, halibut and cod were taken. The sounding was on the NW. extremity of the cod bank before mentioned.

We then ran 10 miles S. 49° W., sounding in 30 and 40 fathoms, the depth increasing to 435 fathoms 11 miles S. 25° E., which showed an

abrupt termination of the bank in that direction. A line was then run N. 49° E. 16 miles, with 52, 50, and 44 fathoms, then N. 64° E. 76 miles, a depth of 42 fathoms being found 4 miles from the last station, increasing irregularly to 72 fathoms about midway between the Sannakhs and the Shumagins, then shoaling to 21 fathoms, broken shells, at the end of the line, 2 miles N. 34° W. from the center of Bird Island, No. 2850, where the trawl and trial lines were put over. A successful haul was made with the former, but, for the first time since our arrival among the Aleutian Islands, we failed to take fish of any kind with the hand lines.

Another successful haul was made in 35 fathoms, gray sand, broken shells, No. 2851, 4 miles N. 48° W. from the last station, and, running 3½ miles N. 40° W., the trial lines were put over in 25 fathoms, gray sand, two sculpins only being taken. The station was midway between the Twins and Near Island. A depth of 27 fathoms was found 3 miles N. 22° E. from the last station; then running S. 78° E. 5 miles, we found 26 fathoms; thence N. 40° E. 4 miles, to 37 fathoms, gray sand and broken shells, when the trial lines were again put over and one halibut taken.

Our experience during the day demonstrated the absence of cod in August in a region in which they are found in great numbers at other seasons of the year; in fact, it is one of the favorite fishing grounds during the winter.

The last station was at the southern entrance of the strait between Spectacle and Big Koniushi Islands. After steaming through an apparently clear passage we found 57 fathoms in midchannel, abreast of the north end of Spectacle Island, N. 20° E., 4 miles from the last station, and 39 fathoms 4 miles N. 10° W., the north end of Peninsula Island bearing N. 80° E. 1½ miles. A successful haul of the trawl was made 5¾ miles N. 20° E. from the last station in 58 fathoms, black sand, Cape Thompson bearing S. 76° E., 5 miles. We then steamed through the passage between the latter cape and Castle Rock, sounding in 23 fathoms about midchannel; then following along the east side of Big Koniushi, we anchored in Yukon Harbor at 6:50 p. m.

Several inaccuracies were observed in the U. S. Coast and Geodetic Survey Chart No. 816, and among the more important may be mentioned the following:

(1) Spectacle Island is about 3 miles in length, high and rounded at both ends and connected by a narrow strip of low land near the center. A deep bight on the east side and a prominent point projecting to the westward give it the general form of a pair of spectacles, from which it derives its name.

(2) Peninsula Island is placed N. 35° E. about 2½ miles from its correct position. It lies directly midchannel of the strait, and is, in fact, the projection shown on the west side of Big Koniushi. A low spit makes off from the east side of the former, but there is a passage between the two islands.

(3) The bays on Big Koniushi, north end, south of Peninsula Island, are much deeper than shown on the chart.

Fog prevailed throughout the night, but cleared as we approached the island in the morning, enabling us to see land at a great distance during the day. A spirited sight was presented to us as we approached Yukon harbor, the surface of the water being literally covered with myriads of kanooskies and crested auks; large flocks of the active little birds filled the air; their flight was exceedingly rapid and erratic, the flocks in the distance reminding one of a dense black cloud within the influence of a tornado.

We left our beautiful little harbor at 3:34 on the morning of August 5, with partially clear pleasant weather, and starting from a point S. 68° E. from Atkins Island, in 27 fathoms, ran a line offshore in the same direction for 25 miles, with depths between 40 and 50 fathoms at the end of the line. A bank of small extent, having from 25 to 30 fathoms, was reported on this line 20 miles from Atkins Island, but we failed to find it.

We ran 5 miles S. 22° W. and sounded in 56 fathoms, then turned inshore N. 68° W. for 25 miles, sounding at equal intervals in 46, 45, 41, 45, and 35 fathoms, the latter 4 miles S. 70° E. from the NE. extremity of Simeonoff Island. We then ran 5 miles S. 22° W., sounding in 38 and 35 fathoms; S. 68° E., 15 miles, in 57, 44, 47, 49, and 55 fathoms; S. 22° W., 10 miles, in 99 fathoms; N. 68° W., 20 miles, in 69, 56, 46, 41, and 35 fathoms; and S. 75° W., 3½ miles, in 35 fathoms; S. 22° E. 4 miles from the south end of Chernabura Island.

We next turned offshore and ran a line S. 28° E., 15 miles, with 43 fathoms at 5 miles and 115 fathoms at the end of the line; N. 81° W., 14 miles, with 105 fathoms; N. 3° E., 15 miles, with 49 fathoms at 10 miles and 42 fathoms at the end of the line; N. 75° W., 5 miles, with 44 fathoms; and S. 29° W., 19 miles, with 49 fathoms at 5 miles, 67 fathoms at 20 miles, and 119 fathoms at the end of the line.

Trial lines were put over in 35 fathoms, 4 miles S. 22° E. from Chernabura Island, and several cod and halibut were taken. This was the only trial during the day, as we wished to utilize the clear weather to locate stations by bearings of the land. Our soundings during the morning did not extend to the 100-fathom line, but terminated within sight of land, where bearings supplemented the ordinary observations, enabling us to attain a greater degree of accuracy than usual in this region.

The 6th was cloudy, but the atmosphere was clear, the Shumagins being visible nearly all day, so that we frequently verified our positions by bearings. Having completed our examination inshore, we ran N. 75° E. 50 miles and sounded in 53 fathoms; then, in order to develop the 100-fathom line offshore from our work of the previous day, we ran N. 80° E. 10 miles, sounding in 57 and 86 fathoms; N. 29° E., 5½ miles, in 110 fathoms; N. 51° W., 6½ miles, in 87 fathoms; and N., 11 miles, in 90 and 114 fathoms.

Turning inshore, we ran a line N. 67° W., 30 miles, sounding in 87, 79, 50, 47, 53, and 58 fathoms at the end of the line, S. 78° E., distant 6 miles from Cape Thompson. Hydrographic Office Chart No. 68 gives 40 fathoms in latitude 54° 36′ 00″ N., longitude 158° 25′ 00″ W., where we found 86 fathoms.

The general aspect of the Shumagins is mountainous, with numerous streams rushing down the mountain sides, often forming cascades of great beauty. Copious rains and a humid atmosphere favor the rank growth of grass, ferns, flowers, etc., which cover the islands during the summer months, and give the impression of great fertility when viewed from a distance. There is no timber on the islands larger than alder bushes, but the beaches are lined with driftwood in sufficient quantities to supply the probable demand for many years. There are but few outlying dangers, and as a rule the shores can be approached within half a mile or less with safety. There are many secure harbors in the group, and vessels can find anchorage almost anywhere near the land in 10 to 20 fathoms. The region off Simeonoff is an exception, however, and should be navigated with great caution, as there is foul ground surrounding the island.

We ran N. 6° W., 5 miles from the last station, and sounded in 102 fathoms, Castle Rock bearing S. 78° W., distant 5 miles; thence N. 84° E., sounding at intervals of 10 miles in 103, 97, 80, 68, 56, and 46 fathoms. Forty-seven fathoms was found 5 miles farther in the same direction, in latitude 55° 25′ 00″ N., longitude 157° 28′ 00″ W., 65 miles from the point of departure, and about 19 miles to the southward of Light House Rocks, to which the bank undoubtedly extends. Increased depths on the above line indicate a marked depression between the Shumagins and the mainland, the extent of which can only be determined by further investigations.

Turning inshore we ran N. 66° W., 25 miles, then N. 45° W., 27 miles, sounding at about 10-mile intervals in 53, 73, 73, 64, and 68 fathoms, the last station being in latitude 55° 54′ 00″ N., longitude 158° 40′ 00″ W. The mainland was sighted soon after daylight, and Mitrofania Island at 8 a. m., but we failed to recognize the latter for several hours owing to fog banks which hung over the land. We were up with the island at 1:30 p. m., August 7, and leaving it on the port hand steamed into the bay of the same name, anchoring off Long Beach at 2:48 p. m. in 15 fathoms, latitude 55° 58′ 00″ N., longitude 158° 47′ 00″ W. (approximate.).

Mitrofania Bay to Old Harbor, Kadiak.—Our anchorage was near the SW. extremity of a steep black sand beach which lies back of the bay, and extends in crescent form about 3 miles NE. and SW. This beach is flanked on the eastern end by a nearly vertical cliff 600 or 800 feet in height, made conspicuous by many strata of different-colored rocks, and on its western extremity by a precipitous mountain covered with a dense growth of alder bushes. An isolated rock lies near the base of

the mountain about 300 yards back of the beach, nearly rectangular in form, the sides being vertical, about 100 feet broad by 60 feet in height, and the top slightly rounded and covered with grass, ferns, and small bushes. Seen from a distance it had the appearance of a huge native sod house (barabara), with the roof overgrown with grass. An extensive valley lay back of the beach, in which were several ponds of fresh or brackish water, their shores being surrounded by a fringe of alder bushes. The land was covered by a rank growth of grass and wild flowers.

Long Beach is a good anchorage, except with winds from S. to SE., when a heavy swell rolls in. Better harbors are found on the east side of the bay. To make this anchorage, leave Mitrofania and the small islands on the port hand, passing midway between them and the mainland until well up with the sand beach, then stand to the westward and anchor off the rock above mentioned, giving due attention to the lead, as the bank is steep.

The collectors went on shore as soon as the anchor was down, returning in the evening with several species of birds, fishes, plants, etc. Trout were plentiful in the larger ponds, and cod and halibut were taken with hand lines from the ship.

A dense fog prevailed on the morning of the 8th, which detained us until 5:25, when, partially clearing, we were able to get under way and steam out of the bay. We took a departure at 6:12 from the following bearings: NW. extremity of Mitrofania Islands, S. 72° W.; east extremity, S. 6° W.; outer point on mainland, N. 14° E.; which, plotted on Hydrographic Office Chart No. 68, placed us in latitude 55° 53′ 00″ N., and longitude 158° 37′ 00″ W. We then ran a line of soundings about S. 77° E., 43 miles, to Light House Rocks, and at 12:30 p. m. anchored in 49 fathoms, 890 yards N. 28° E. from the largest.

The group consists of several detached rocks ranging from 90 feet in height and 500 feet in length, to 10 feet in height, with two or three nearly awash, over which the sea was breaking. They are about 500 yards in extent, and can be approached within half a mile with safety. No two charts agree as to their location, giving it from latitude 55° 44′ 00″ to 55° 45′ 00″ N., longitude 157° 25′ 00″ to 157° 30′ 00″ W. It was our intention to verify their position, but a dense fog, which settled down soon after we left the mainland, prevented. Our run placed them in 55° 43′ 00″ N., and 157° 20′ 00″ W., but was not sufficiently reliable to justify us in changing their position on the chart. Latitude 55° 44′ 00° N. and longitude 157° 25′ 00″ W. is about the mean, and not far from correct.

They are entirely barren of vegetation, but harbor an extensive rookery of sea lions, which covered nearly the whole surface of the rocks. Sea birds were nestling among the cliffs, and the naturalists collected several specimens with their eggs and young. They also brought off the skin of a large sea lion, 13 feet in length, which was preserved in salt. The hand lines were put over, but no fish were taken, the sea lions having driven them away from the vicinity. We left the rocks

at 4:12 p. m. and ran a line of soundings S. 79° E., 33 miles, in 49, 48, 49, 50, 55, and 135 fathoms; N. 31° E., 24 miles, in 137 and 119 fathoms, the latter being midway between the Semidi and Chirikof Islands. A line was then run S. 36° E., 29 miles, sounding in 89, 60, and 96 fathoms, and N. 23° E., 20 miles, in 57, 26, and 27 fathoms, terminating 6 miles S. 22° E. from the north end of Chirikof Island. Trial lines were put over and codfish taken in abundance. We reached the island early on the morning of the 9th after a night of dense fog, which lifted sufficiently to allow us to locate the last station by bearings.

Leaving the island, a line was run S. 34° E., 12 miles, sounding in 76 and 287 fathoms; N. 28° E., 32 miles, in 89, 81, 76, 60, and 37 fathoms, terminating S. 17 miles from the S. end of Tugidak Island. Trial lines were put over, resulting in the capture of 47 codfish in a few minutes, the ship drifting rapidly in the meantime. A line was then run S. 50° E., 13 miles, sounding in 61, 66, and 159 fathoms gray sand, where a successful haul of the trawl was made. Then turning inshore we ran a line N. 14° E., 29 miles, in 75, 54, and 28 fathoms, terminating 4 miles S. 14° W. from Sikhinak Island.

The fog lifted as we approached the land, giving us a very good view of the Trinity Islands. Tugidak and the western portion of Sithinak Islands are low and apparently marshy, while the eastern portion of the latter is higher. They are surrounded by foul ground, and in the absence of proper surveys should be approached with caution.

Leaving the islands, we ran a line S. 56° E., 30 miles, sounding in 23, 52, 46, 52, and 88 fathoms; N. 19° W., 23 miles, sounding at 10 miles in 36 fathoms, followed by 45 and 73 fathoms; then N. 74° E., 38 miles, sounding at intervals of about 5 miles in 53, 58, 49, 44, 51, 49, and 37 fathoms. Trial lines were put over at the last station and several halibut taken. Turning inshore a line was run N. 62° W., 28 miles, sounding in 61, 37, and 60 fathoms, No. 2854, where a successful haul of the trawl was made. Continuing the same course 4 miles we found a depth of 18 fathoms 3½ miles S. 21° E. from Black Point, the south end of Sitkalidak Island. A successful haul of the trawl, No. 2855, was made at the entrance to Kiyavak Bay in 69 fathoms, 5 miles N. 62° W. from the last station. Two soundings were subsequently taken at 5-mile intervals on a north course, in 68 and 57 fathoms, the latter off the entrance to the Bay of Three Saints.

Old Harbor to St. Paul, Kadiak.—At 2:05 p. m., August 10, we anchored in 7 fathoms in Old Harbor, latitude 57° 11′ 00″ N., longitude 153° 13′ 00″ W., off an Indian village called by the natives Three Saints. It lies about 4 miles to the northward of the bay of Three Saints, the beautiful harbor of Lisiansky Bay intervening.

The country surrounding Old Harbor is mountainous, with a narrow belt of comparatively level land, on which the village stands near the water. It is covered with a luxuriant growth of grass and flowers during summer. Alder bushes grow to greater size than on the islands

farther to the westward, and in the sheltered valleys the poplar is found of sufficient size to make it valuable to the natives in building their houses and for other purposes. The rugged mountain range, sometimes called the backbone of Kadiak, was in sight, and the great gorges, still filled with snow and ice, lent an Arctic hue to the otherwise summer aspect.

To enter Kiyavak Bay, make Two Headed Island (miscalled Two Headed Cape, C. S. Chart No. 702), which has two irregularly rounded peaks and is easily recognized. Leave it on the port hand, and, if the weather is clear, Black Point will be seen, showing darker than its surroundings. There is a small islet, about 200 yards in prolongation of this point, and one-fourth of a mile farther on is a rock, just above water, which marks the outer end of a ledge extending from the point. Having passed this rock, a mid-channel course around the second prominent point, on the starboard hand, leads to the strait, where Old Harbor is located, and off which lies the Bay of Three Saints and Lisiansky Bay. There is bold water in the strait, which is free from hidden dangers, except near the land. Passing Old Harbor there is a narrow tortuous channel into Sitkalidak Strait, through which small vessels have passed, but a stranger should not attempt it with a vessel drawing more than 8 feet.

We were surprised by the shrill whistle of a steam launch a little after dark, which soon came alongside with Mr. Ivan Petroff on board. He is manager of the Alaska Coast Fishery Company station at Port Hobron, some 10 or 12 miles to the northward and eastward of Old Harbor. An Indian messenger reported the *Albatross's* arrival, and he lost no time in paying us a visit. His launch required some small repairs, for which we furnished materials.

I visited the station on the following day and found it located in a snug little harbor on the north side of Sitkalidak Island, the second deep bay coming from seaward. The quarters, mess room, store and kitchen are under one roof, and the curing house is at the water's edge, where boats or barges can load and discharge at half tide. It is supplied with running water from a mountain stream, and everything was scrupulously clean and well arranged. A cooper shop, stable, and storehouse are conveniently located, and in the harbor were several dories, barges, and a fine schooner, in addition to the steam launch already mentioned. This is the first season the station has been in operation, and they have thus far confined themselves to taking and salting salmon, but they intend starting a cannery eventually. The fish are mostly caught in a lake a mile from the bay, opposite the station, and transported over a horse railway to the beach, where they are transferred to barges or dories which deliver them at the curing house. Our visit occurred between the runs of salmon, and we found the entire force, except the coopers, engaged in cutting and curing hay for the horses used at the station. The location seems to be well chosen, not only for salmon fishing but for cod and halibut.

A dense fog prevailed on the morning of the 12th, detaining us until 2 p. m., when it partially cleared and we steamed out of Kiyavak Bay. Taking a departure from a point 5 miles N. 72° E., from the center of Two Headed Island, in 71 fathoms, we ran a line S. 48° E., 46 miles, sounding in 111, 60, 46, 38, and 347 fathoms, and N. 38° E., 22 miles, in 173 and 29 fathoms. Then, to ascertain the distance our newly discovered bank extended off shore, we ran S. 67° E., 10 miles, sounding in 60 and 296 fathoms, and N. 38° E., 12 miles, where we found a depth of 495 fathoms, which indicated that we were outside of the bank.

Lines were run N. 41° W., 44 miles, sounding in 58, 49, 44, 86, and 53 fathoms, the latter station being 4 miles S. 32° E. from the extreme point of Dangerous Cape, then S. 45° E., 11 miles, in 39 and 25 fathoms, where we anchored at meridian, August 13, to wait the lifting of a dense fog, which obscured everything more than a ship's length from us.

Cod and halibut were taken with hand lines in great abundance at the anchorage as well as at the previous station in 39 fathoms. The weather cleared partially half an hour after we anchored, and Ugak Island was found to bear N. 44° E., distant 4 miles. We got under way at 12:53 p. m. and ran a line S. 35° E., 35 miles, sounding in 45, 43, 46, and 90 fathoms, a notable feature being the absence of the depression between the bank and shore line of Kadiak, which we found farther south.

From the end of the line we ran N. 41° E., 15 miles, sounding in 75 fathoms, and N. 53° W., 35 miles, sounding in 71, 31, 57, and 81 fathoms, the last position being S. 60° E., 5 miles from Cape Greville, which, with Ugak Island, enabled us to locate our last positions by cross bearings. It was partially clear during the evening, although fog banks hung over the land, the more prominent points only being visible. It was very thick inside of Cape Greville, so we hove to from midnight until 3:27 a. m., August 14, when we steamed toward the Cape, and making the rocks lying off it, we ran WNW. (mag.) for Long Island, which has a bold, clear shore, much safer to make in thick weather than the Outer Humpback.

The fog lifted, however, before we reached the rock, and steering for it we passed within half a mile; then stood over for the south end of Popoff Island until we were in midchannel; thence for the usual anchorage off the astronomical station, St. Paul, where we anchored at 6:15 a. m., in 13 fathoms.

Directions for entering St. Paul.—In coming from the southward make Ugak Island, then Cape Greville (known locally as Chiniak Point). The east or seaward side being free from dangers, can be approached with safety, but a ledge of rocks which makes off to the northward must be left on the port hand. The rocks are above water, and being prominent should be cleared without difficulty if the cape has been sighted, and no vessel would attempt to pass inside without seeing it. The lead should be used in thick weather, as the outer limit of Portlock Bank is well defined, and from 35 to 40 miles distant.

Having cleared the rocks off the cape, stand WNW. (magnetic) for Long Island, which will carry a vessel about three-quarters of a mile outside of the Outer Humpback. If it is not seen, the island will be the next land-fall, and can be approached with comparative safety. Outer Humpback should be seen if the weather is suitable for a stranger to make the harbor, in which case pass within one-quarter to one-half mile, leaving it on the port hand, and steer W. ½ N. (mag.) for the south end of Popoff Island. When the passage between Wooded Island and Long Island is shut in, steer N. by W. ¼ W. (mag.) for the channel, passing 100 yards from the point of Wooded Island, off the settlement; continue the course until the storehouse on the wharf at St. Paul opens out, then stand in for the anchorage off the astronomical station (C. and G. S. Chart No. 776), anchoring in about 13 fathoms. The Wooded Island side of the channel should be favored to avoid a reef on the west side, and the course continued to clear a rock about one-eighth mile off the north end of Holiday Island, which is not shown on the chart.

To enter the inner harbor keep the crib, lying just off the end of the wharf about 50 feet from Near Island, open until nearly up with it, sailing as close as practicable until inside of the reef, and then steer for the wharf. A vessel should enter with the tide running a little flood, which sets to the northward. The channel is very narrow, and a stranger should not attempt it without a pilot. It is high water at the wharf, full and change, at 1:00 hour.

I called on Mr. M. L. Washburn, agent of the Alaska Commercial Company, soon after we anchored, and he assured me that he would be pleased to do anything in his power to forward our work. He informed me that provision had been made to supply us with 100 tons of coal, and delivered a large mail with dates to August 1. The company's steamer *Bertha* arrived on the 17th and left for San Francisco at 1 p. m. the following day, carrying our mail. The *Karluk* came in at 1:30, and at 3 p. m. the *Albatross* entered the inner harbor and moored to the wharf. We commenced coaling at 5:30 on the morning of the 20th, and finished at meridian the following day, having taken on board 100 tons.

We left the wharf 2 hours later, steamed to the outer harbor, landed our pilot on Wooded Island, and proceeded to sea. At 3:24 p. m. we sounded in 69 fathoms, S. 36° W., 1¼ miles from the south end of Long Island, and at 3:50 in 17 fathoms, N. 24° E., 0.4 mile from the Outer Humpback.

Kadiak to Middleton Island.—The development of Portlock Bank was then commenced by running the following lines of soundings: N. 53° E., 15 miles, in 28, 37, and 47 fathoms; S. 51° E., 50 miles, in 30, 33, 35, 38, and 42 fathoms, at intervals of 5 miles; 48 and 57 fathoms at 10 miles intervals, and 72 fathoms at the end of the line. It was completed a little after midnight, and, the weather being favorable, we located our positions with accuracy. The 22d was partially cloudy, with light variable winds and smooth sea, admirable weather for our

work. We ran a line N. 67° E., 17 miles, sounding in 200 fathoms; then N. 51° W., 63 miles, in 59, 51, 43, 40, 36, and 78 fathoms, at intervals of about 10 miles, and 68 fathoms, No. 2856, 5 miles further, at the end of the line, where a successful haul of the trawl was made. The station was occupied at noon; the latitude was obtained by meridian altitude of the sun, the longitude by chronometer, and both verified by bearings of the land, all of which showed Marmot Island to be improperly placed on the Coast and Geodetic Survey Chart No. 702, in accordance with which its nearest point would be 9 miles distant, yet we could see the surf breaking on the beach not more than 5 miles away.

It will be observed that the last two lines vary in depth from soundings shown on the chart, and seem to indicate the extension of Portlock Bank to Cape Greville without the intervening depression so generally found in this region near the land. Trial lines were used at Station 1521 in 36 fathoms, where cod and halibut were taken, the former in great abundance.

Starting soon after noon, a line was run N. 45° E., 18 miles, sounding in 41 and 60 fathoms; then S. 52° E., 61 miles, sounding at intervals of 10 miles in 56, 61, 102, 114, 113, and 140 fathoms off the eastern extremity of the bank. A successful haul of the trawl was made at Station No. 2857 in 51 fathoms, gray sand and black specks. Codfish and flounders were taken with the hand lines. The afternoon being clear and the sea smooth, we availed ourselves of the unusually favorable opportunity to swing ship for compass errors.

From the end of the last line we ran N. 45° E., 18 miles, sounding in 119 and 166 fathoms; then N. 55° W., 65 miles, in 112, 128, 69, 37, 37, 50, 99, and 99 fathoms. Trial lines were used at Station No. 1436 in 37 fathoms, and several codfish taken. The line was completed about 2 p. m., August 23, when we ran N. 27° E., 19 miles, sounding in 76 and 97 fathoms. The Chugatz Islands, Point Gore, and the Pye Islands were in sight during the afternoon, and cross bearings were taken frequently to verify our positions. Many snow-capped mountains were visible on the mainland, and in Nuka Bay an immense glacier extended apparently to the water's edge.

From the last station a line was run S. 51° E., 98 miles, sounding in 84, 105, 69, 67, 84, 90, 84, 77, 98, and 507 fathoms; N. 56° E., 10 miles, in 594 fathoms; N. 3° W., 10 miles, in 761 fathoms; and N. 53° W., 10 miles, in 230 fathoms, where at 11:38 a. m., August 24, we made a successful haul of the trawl, No. 2858. As soon as the haul was completed, we ran a line N. 38° W., 47 miles, sounding at intervals of about 9 miles, in 71, 66, 71, 103, and 122 fathoms; S. 56° E., 62 miles, in 118 fathoms at 17 miles, and 99, 106, and 902 at equal intervals to the end of the line. We then ran N. 20 miles, sounding in 358 and 151 fathoms; S. 62° E., 10 miles, in 301 fathoms; N. 25 miles in 537, 78, and 161 fathoms; N. 78° E., 9 miles, in 308 fathoms; and N. 63° E., 30 miles, in 252, 109, and 92 fathoms.

Middleton Island.—Middleton Island was sighted at 2:08 p. m., bearing S. 88° E. I determined to locate it if our clear weather continued through the following day. With this object in view we ran 9 miles N. 80° E., and sounded in 43 fathoms; N. 57° E., 5 miles, in 11 fathoms, and then anchored about a mile to the northward, in 12 fathoms, near the point indicated on the Coast Survey chart, the north end of the island bearing N. 52° E., and the south end S. 27° W. We were off the outer limit of kelp, which seemed to extend the whole length of the island, from ½ mile to 1½ miles from the beach. We were on the weather shore, where a moderate NW. wind and strong tide caused a heavy surf, so we deferred landing until the following morning. The rock mentioned in the Alaska Coast Pilot as lying 3 miles SW. (magnetic) from the north point of the island, and NNW. (magnetic) from the anchorage, was not seen, and if it exists is below the surface, where rocks may be encountered almost anywhere around this desolate island. The swell was so heavy that no soundings were made except in the immediate vicinity of the anchorage. Observations of the tides during the night showed a velocity of 2 to 3 knots per hour, the flood setting to the northward and eastward and the ebb in the opposite direction.

August 26 commenced with a moderate breeze from the SW., veering to NW., NE., and ESE., with clear weather, except for 2 hours in the early morning. The surf was still too heavy for landing, and being anxious to get observations on shore, as well as to give the collectors an opportunity to examine the region, we got under way and steamed to the southern end of the island. We were about to anchor in 16 fathoms, when the keel came in contact with a rock, but we backed off without damage, and anchored in 15 fathoms, the northern end of the island bearing N. ½ E. (magnetic), and the southern extremity NE. ⅜ N. (magnetic).

A party of collectors, the navigator, and myself landed, and while the former were searching the island for specimens, the following observations were taken: Two sets of equal altitude of the sun for longitude, one meridian altitude and six ex-meridian altitudes of the sun for latitude, the artificial horizon being used. They were made under favorable conditions and are reliable. The observation spot is one cable to the westward of the SE. extremity of the island, and is marked by a pile of stones on the beach above high water, the mean of all the sights placing it in latitude 59° 23′ 36.7″ N. and longitude 146° 19′ 33.4″ W.

Middleton Island is between 7 and 8 miles in length, N. 22° E. and S. 22° W., with reefs extending 2 miles or more north and east of it and between 3 and 4 miles off the southern end. The anchorage is off the west side, and an approaching vessel should keep well outside the kelp, as rocks may exist anywhere near the island, which is a terminal moraine, composed of mud, clay, gravel, and huge boulders, scattered about over the surface, on the beach and on ledges above and below the water. The southern end has perpendicular cliffs of mud and clay

from 30 to 80 feet in height, the greatest elevation toward the center of the island being about 120 feet above the sea. The strata on this side dip from 30° to 40° about NW. (magnetic). The general appearance of the island is flat and, the soil being impervious to water, numerous ponds are formed by heavy rains, and the entire surface is moist, almost boggy, covered in summer with a rank growth of grass, flowers, etc., but no trees occur. Cormorants, gulls, and puffins were nesting on the cliffs, and the burrowing habits of the latter made walking near their haunts very difficult. The island is uninhabited, except by hunters, who are occasionally left there to search for seals and sea otters.

Having finished our observations, we returned to the ship and got under way at 8 p. m., and at 3:40 sounded in 22 fathoms, latitude 59° 19′ 00″ N., longitude 146° 23′ 00″ W.; then ran S. 53° E. 5 miles and sounded in 141 fathoms, 10 miles in 620 fathoms, and 20 miles in 2,425 fathoms. The course was then changed to N. 74° E. for Pamplona Rocks. The day ended with clear, pleasant weather and smooth sea, which continued on the 27th.

Pamplona Rocks to Departure Bay, British Columbia.—Having run 40 miles from last station, we sounded in 2,224 fathoms, 27 miles further in 2,138 fathoms, and 17 miles still further in 1,528 fathoms. Changing the course to S. 51° E., we ran 17 miles to the position assigned to the rocks, then S. 16° W. 3 miles, and sounded in 1,763 fathoms; E. 5 miles and S. 28° W. 7 miles to another reported position, where we found 1,745 fathoms. Then, changing the course to N. 70° E., we ran 9 miles and sounded in 1,675 fathoms; N. 84° E. 10 miles, in 1,500 fathoms; and S. 43° E. 10 miles, in 1,548 fathoms.

The position assigned to Pamplona Rocks on Coast Survey Charts 701 and 702, Hydrographic Office Chart No. 527, and in the Alaska Coast Pilot, is latitude 59° 03′ 00″ N. and longitude 142° 40′ 00″ W.; but Coast Survey Chart 960 places them in latitude 59° 35′ 00″ N., longitude 142° 04′ 00″ W. I consider it highly important that these dangers should be located in the interest of commerce as well as of the fisheries, and as the time would not permit an examination of both localities, we selected that which seemed to have the weight of evidence in its favor. The weather was remarkably clear and the search was made during the middle of the day with a lookout on the topgallant yard, his line of vision extending 10 miles or more on either hand, without detecting any signs of rocks or shoals. The soundings were regular and gave no indication of shoaling water, so it may be stated positively that the rocks do not exist within 20 miles of the assigned position.

Coast Survey Chart No. 960 places them nearer land, where from 40 to 50 fathoms are found in their vicinity, and where rocks, banks, or a ledge, as these dangers are called by different authorities, might be expected to exist. The snow-capped heights of Mount St. Elias were visible during the day, from 90 to 100 miles distant, and many snowy peaks of less magnitude could be seen from time to time.

The weather was overcast and rainy during the first part of the 28th, with a heavy swell from the southward, but it cleared after noon and the swell moderated. A sounding was made in 1,815 fathoms, gray ooze, 50 miles S. 43° E. from the last station, and another 50 miles further in 1,778 fathoms. Two soundings were made during the 29th, the first in 1,433 fathoms, latitude 56° 35′ 00″ N., longitude 137° 55′ 00″ W., and the latter, No. 2859, in 1,569 fathoms, latitude 55° 20′ 00″ W., where a successful haul of the trawl was made. An accident to the dynamo deprived us of the use of the electric lights, and the Sigsbee deep-sea sounding machine was partially disabled, but we used it until our arrival in port.

The soundings were made on the 30th, in 1,571 fathoms, latitude 54° 02′ 00″ N., longitude 134° 34′ 00″ W., and 1,601 fathoms, latitude 52° 32′ 00″ N., longitude 133° 05′ 00″ W. We sighted Queen Charlotte Island at 12:45 p. m., and were off Port Keeper at 6. A cast of the lead was made the following morning in 1,099 fathoms, SW. ½ S. (magnetic) 25 miles from Cape St. James, and at 9 a. m. a successful haul of the trawl, No. 2860, was taken in 876 fathoms, green mud, latitude 51° 23′ 00″ N., longitude 130° 34′ 00″ W., and another at 2:50 p. m., No. 2861, in 204 fathoms, latitude 51° 14′ 00″ N., longitude 129° 50′ 00″ W. Soundings were made at 6:44 p. m. in 83 fathoms, latitude 51° 09′ 00″ N., longitude, 129° 07′ 00″ W., and at 10 p. m. in 52 fathoms, latitude 51° 01′ 00″ N., longitude 128° 25′ 00″ W., where we anchored for the night.

The fog shut down a few minutes later, and continued with momentary breaks until noon of September 1. We got under way at 8:10 a. m., felt our way into Goleta Channel, and made a successful haul of the trawl at 12:30 p. m., No. 2862, in 238 fathoms, gray sand and mud, Duncan Island bearing ENE. ½ E. (magnetic), Noble Island, N. ¼ W. (magnetic). The trawl came up with a heavy load of mud, which detained us two hours or more, as we were obliged to tow it until it was relieved of sufficient weight to enable us to land it on deck. The haul proved very rich, particularly in specimens of brachiopods, among which were several rare, if not entirely new, species. We steamed ahead on our course as soon as the trawl was landed, anchoring in Albert Bay at 5:10 p. m.

We were under way at 4:30 on the morning of the 2d, the weather overcast and misty but clearing gradually during the morning. We passed Seymour Narrows at 12:45 p. m., nearly high water, and at 6:15 p. m. anchored in Tribune Harbor for the night. The sky was nearly cloudless during the afternoon, but the atmosphere was thick with smoke from forest pines, which becomes so dense at times that it is more dreaded than fog. At 6 a. m. September 3, we got under way, arriving at Departure Bay at 10 a. m. and going to the wharf an hour later. We began coaling at 1:05 p. m. and finished at 2 p. m. on the 4th, having taken on board 112¾ tons.

COASTS OF WASHINGTON AND OREGON.

Departure Bay to Seattle, Washington.—Leaving port at 7 a. m., September 5, we steamed to the southward and eastward through mist and rain, until 10:55, when the trawl was cast, No. 2863, in 67 fathoms, making a successful haul. Resuming our course, we passed Rosario Straits and at 5:25 p. m. anchored in Burrows Bay for the night. It is a good harbor, and is protected from all but southerly winds. We were under way at 6:05 the following morning, and at 7:15 cast the trawl in 48 fathoms, No. 2864, making another successful haul. A third cast was made at 8:55 in 40 fathoms, No. 2865, and a fair haul taken, although the trawl capsized and was dragged bottom up, the first time that had happened for several years. Steaming ahead as soon as the trawl was landed, we passed Point No Point at meridian and anchored off Seattle, Washington, at 2:45 p. m., September 6. I called on the mayor, Robert Moran, on the 7th, and the call was returned the following day by the mayor and city council, who inspected the vessel and her equipment and expressed great interest in our work.

Outer coast of Washington.—We left Seattle at 10:40 a. m., September 17, and anchored in Port Townsend at 3:45 p. m. I met Judge James G. Swan the following morning, and had a conference with him regarding the fisheries of Washington and other matters connected with our work. He had lived many years on the coast between Gray's Harbor and Neeah Bay, and from close observation had acquired a remarkable knowledge of the fauna of this region. His information respecting the Indian tribes and their habits has led him to believe that halibut will not be found in paying quantities south of Cape Flattery. It was, he said, a time-honored custom for the tribes living as far south as Flattery Rocks to go to Cape Flattery every spring for their winter's supply of halibut, which were taken on the well-known bank from 9 to 12 miles WNW. (magnetic) from Tatoosh Island. Halibut have seldom been taken south of Cape Flattery, and never, to his knowledge, south of Flattery Rocks. They form no part of the winter's food of tribes inhabiting that part of the coast, rock-cod, surf smelt, tomcod, salmon, etc., being the staple supply. He thinks that if halibut existed near the shore the Indians would have known it and, like the tribes farther north, would have taken them for winter use. He predicted that we would find a clean sand bottom with very little life between Cape Flattery and Gray's Harbor.

The Coast Survey steamer *McArthur* arrived during the afternoon and permitted us to copy their soundings about Cape Flattery, a saving of time and labor, as we would have been obliged to sound over a portion of the same ground.

We were under way at 5:45 p. m. September 18, passed Cape Flattery at 2 a. m. the following morning, and at 5:30 commenced a line of soundings in 82 fathoms, S. 68° W., 10 miles from the light. It was extended 35 miles S. 68° W., sounding at intervals of 5 miles, to develop

banks reported to exist 60 and 75 miles from the cape. The depths were irregular for 30 miles, then increased uniformly to 768 fathoms at the former and 1,239 fathoms at the latter position. The reports were from shipmasters who said they had sounded on the banks and knew they were there. No doubt they found 60 or 70 fathoms as reported, but they were 15 or 20 miles out in their reckoning.

The wind began blowing from the southward and eastward soon after we passed Cape Flattery, and became a moderate gale at 7 a. m., with a heavy swell, which increased during the day. At 4 p. m., when the line was finished, the sea was too rough to continue work, so we lay to several hours, then steamed in shore under low speed until we sighted Flattery Light, and lay to again until 7 a. m., September 20. The wind moderated during the night, the rain ceased, and the weather partially cleared. The sea went down also, but a heavy swell rolled in from the southward and westward, causing the vessel to tumble about badly whenever she was allowed to get in the trough of the sea. Vivid lightning was observed during the night over the land in the direction of the Olympian range.

The trawl was cast at 11 a. m in 171 fathoms, No. 2866, S. 40° W., 19 miles from Flattery light-house, and although the swell was still heavy the haul was successful. Another haul was made at 1:40 p. m. in 37 fathoms, No. 2867, S. 23° W., 17 miles from the light, and at 3 p. m. we set the trawl line in 31 fathoms, gray sand, near the last station. It was allowed to remain on the bottom 2 hours, and on hauling it 3 dogfish, 8 sharks, and 1 halibut were taken, the latter weighing about 140 pounds.

At 7:34 p. m. we sounded in 178 fathoms, gray sand, S. 34° W., 19 miles from Flattery light, and ran a line 30 miles S. 68° W. in 77, 82, 218, 90, 141, and 378 fathoms; S. 82° E., 15 miles, in 247, 462, and 522 fathoms; and N. 73° E., 25 miles, in 378, 206, 67, 52, and 31 fathoms. The trawl line was set at the last station, taking one skate (*Raia cooperi*), one dogfish (*Squalus acanthias*), two starfish, and two fish not recognized. A successful haul of the trawl, No. 2868, was made while the line was down, but the bottom was found to be comparatively barren. Trial lines were put over the side without result.

We then ran S. 36° E., 15 miles, nearly parallel with the coast, sounding in 30, 33, and 32 fathoms, the trawl being lowered at the last station, No. 2869. The bottom was composed of fine gray sand, perfectly clean, without adhering growths of any kind. A line was then run offshore S. 73° W., 20 miles, sounding in 53, 75, 111, and 287 fathoms; then S. 17° E., 15 miles, in 535, 758, and 578 fathoms; turning in shore we ran N. 73° E., 20 miles, sounding in 386, 82, 51, and 28 fathoms; S. 17° E., 15 miles, in 28, 28, and 28 fathoms; and S. 70° W., 25 miles, in 41, 56, 74, 93, and 438 fathoms. Rocky patches alternated with fine gray sand and mud on the last line, denoting a marked change from the uniform gray sand found thus far south of Cape Flattery.

A report of Indian origin placed a bank 30 miles west (magnetic) from Shoalwater Bay. The change in the character of bottom led us to believe that the report might be correct, and a careful examination of the region resulted in the development of a bank about 20 miles in length, SW. and NE. (magnetic), and 12 miles in extreme width. Its eastern extremity, on which is 42 fathoms, rocky bottom, lies 15 miles SW. (magnetic) from Point Chehalis, the southern extremity of Gray's Harbor. The soundings are quite regular, but the character of the bottom alternates between rock, gray sand, and mud. A trawl line was set at 5:52 a. m., September 23, in 58 fathoms, rocky bottom, No. 2870, on the southern edge of the bank, 2 black cod (*Anoplopoma fimbria*), 4 sharks, and 10 red rockfish (*Sebastichthys ruber* and *Sebastichthys pinniger*) being taken. A haul of the beam trawl was made also, which developed more life on the bottom than had been found south of Cape Flattery, and indicated good feeding ground for fish. There is little doubt that at the proper season good fishing may be found on this bank. Several red rock-cod were taken with hand lines from the ship's side.

As soon as the haul was completed we ran 28 miles N. 72° W., and at 1:17 p. m. cast the trawl in 559 fathoms, brown ooze, No. 2871. The haul was successful, although made at great risk, owing to the heavy westerly swell which still rolled in. The surface net was towed as usual, but very little life was found.

We steamed ahead under low speed for Cape Flattery, and at 7:26 a. m., September 24, cast the trawl in 38 fathoms, gray sand, No. 2872, S. 40° W., 8 miles from the light-house, taking but few specimens. The trawl line was set, and 2 sharks and a starfish were the only catch, the baits being left undisturbed. Two red rockfish were taken with hand lines.

The haul finished, we steamed across the Straits of Fuca, and at 12:15 set the trawl line in 40 fathoms, No. 2873, N. 53° W., 10½ miles from Cape Flattery light-house. The trawl was lowered, but caught at once on the rough, rocky bottom, and the frame was lost, the wreck of the net coming up with the bridle. The tangles were then lowered in 27 fathoms, rock and shells, No. 2874, N. 55° W., 11.3 miles from the light-house, the results showing a rich bottom fauna, or "live bottom," as fishermen call it, which is usually found on halibut grounds. Another haul of the tangles, No. 2875, was made over the same ground with similar results. The trawl line was allowed to remain on the bottom 3 hours, and when hauled 4 halibut, 2 sharks, 4 red rockfish, and 3 starfish were found on the hooks. The operations above described were on the well-known bank where in spring and early summer halibut are found in great numbers, and where the Indians from Cape Flattery have for many years procured their winter's supply.

A heavy westerly swell still rolled in, making it rather uncomfortable on board, except when head or stern to it, the result of remote gales which did not blow home. Wishing to make a harbor for the night,

we ran for Neeah Bay, where we anchored at 5:40 p. m. A trawl line was set outside of the harbor in 25 fathoms, and when hauled next morning dogfish and skate were found to be the principal catch.

Off Barclay Sound, Vancouver Island.—We left Neeah Bay at 8 a. m. on the 25th, steamed across the straits, and at 10:07 set the trawl line and cast the beam trawl in 59 fathoms, black sand and mud, No. 2876, 14.7 miles south from Cape Beale light-house, Vancouver Island. The trawl dragged but a few yards when it caught on a rocky patch, parted the bridle stops, and came up tail first. It was a successful haul, nevertheless, many specimens being found in the net. The tow net was used on the surface and from 2 to 3 fathoms below, but the results were meager, very little life being found. The tangles were hauled over the same ground, No. 2877, with good results, showing the same rich fauna previously found on this bank. The trawl line remained on the bottom 3 hours, and when hauled 2 halibut, 9 dogfish and 1 red rockfish were found on the hooks. One specimen of the latter was taken with the hand line.

At 2:35 p. m. the trawl line was set and the dredge lowered in 66 fathoms, gravel and pebbles, No. 2878, S. 48° W., 16 miles from Cape Beale light-house. The dredge showed but little life on the bottom, except a variety of minute mollusca, and the tow net developed a limited surface life. On the trawl line were found 2 ground sharks, one of large size, 2 common sharks, 15 dogfish, and 3 black-cod. We lay to after the line was up, keeping Cape Beale in sight until 1 a. m. on the 26th, then started ahead to the northward and westward under low speed, and at 5:50 p. m. set the trawl line and lowered the dredge in 34 fathoms, rocky bottom, No. 2879, N. 79° W., 27 miles from Cape Beale. The latter brought up a variety of small mollusca, but nothing indicating live bottom. Another haul, No. 2880, was made over the same ground with similar results, and the trawl line secured 2 sharks, 3 dogfish, and 1 halibut.

We set the line again at 11:05 a. m. in 24 fathoms, fine gray sand, No. 2881, Cape Beale bearing S. 62° E., 26 miles, the result being 1 halibut, 5 dogfish, 1 shark, and 1 skate. Several dogfish were taken with hand lines, and the dredge was hauled over a rough bottom with meager results. We then ran into Barclay Sound, and at 5:55 anchored in entrance anchorage for the night. The naturalists being anxious to make collections, we remained during the 27th for that purpose and were detained on the 28th by fog. The time was utilized, however, by the naturalists, who found a rich field among the islands and rocks. The only evidence of civilization was the light-house on Cape Beale, the Indian villages being mostly abandoned, the occupants having gone to the salmon canneries in the interior. Several canoe loads were seen passing, a few came alongside, and occasionally one was seen trolling for salmon, which were very plentiful.

There was a dense fog on the 29th, until 7 a. m., when it partially

cleared, and we left the sound. It shut down at 8, soon after we passed Cape Beale, and continued until late in the afternoon. The trawl line was set at 10:20 in 60 fathoms, fine sand and rocks, S. 14° E., 22 miles from Cape Beale, and when taken up 2 hours later we found on the hooks 3 halibut, 2 black-cod, and 16 dogfish.

It became evident that sharks and dogfish had possession of the fishing banks at this season to the exclusion of food-fishes, while in the spring and early summer, when halibut are plentiful, only a few of these pests are found; there has been no fall fishing here before, and consequently no information concerning the time they leave the coast and halibut and other valuable species return.

Straits of Fuca and Puget Sound.—As soon as the trawl line was up we started for Neeah Bay, where we anchored at 4 p. m. The Coast Survey steamer, *McArthur*, was in the harbor, making preparations to go to San Francisco, having completed her season's work. Leaving the bay at 7:50 a. m. on the 30th, we arrived at Port Townsend at 4:48 p. m., and anchored for the night. Judge Swan visited the ship at 8 the following morning for a conference relative to our recent investigations, and also in regard to our future work.

Some slight repairs to the machinery being required, we left for Seattle at 10:05, October 1, anchoring off that place at 2 p. m. I called on the mayor of the city an hour later, and gave him an account of our cruise, and what we had learned concerning the coast fisheries of Washington Territory. The necessary repairs being completed we left Seattle at 10:55 a. m., October 4, and anchored in Port Townsend at 3:30 p. m. I called on Judge Swan soon after our arrival, and gave him an invitation to make a cruise with us for a week or two, which he accepted. A large party of citizens of Port Townsend visited the ship during the 5th, and at 6 a. m. the following day we got under way and steaming across the straits, anchored in Royal Roads, the outer harbor of Victoria, at 9:30. I went on shore at 10 a. m., in company with Judge Swan, and called on the United States consul and others.

Mr. Henry Saunders, an enterprising fish-dealer, having recently engaged in the development of the black-cod fishery, we called on him to make inquiries. He informed us that his schooner brought down 3,000 fish on her first trip, when she had an Indian crew. She had gone on a second voyage manned by Newfoundland fishermen, and he anticipated better results. The fish were caught off Queen Charlotte's Island, in from 200 to 220 fathoms, were very plentiful, and took the hook readily. These fish are highly prized where known, and are destined soon to occupy a leading place among the deep-sea fishes of the Pacific coast. I can testify to their excellence when fresh, salted, or smoked. We called also on Mr. George Vienna, the largest fish-dealer in the city, and gained much information regarding the local fisheries.

Leaving Victoria at 6 a. m. on the 7th, we arrived at Departure Bay at 3:30 p. m., and went to the wharf at 6 the following morning. We

commenced coaling at 7 and finished at 11 a. m. the following day, having taken on board $149\frac{1}{2}\frac{680}{2240}$ tons (30 tons being in bags on deck). We were under way at 6:05 on the morning of the 10th, entering Active Pass at 10:40, and set the trawl line at 4 p. m., in 101 fathoms, sand and gravel, off Race Rocks, taking 41 dogfish.

Outer coast of Washington.—It was foggy during the night, lighting up at intervals. Made Cape Flattery light at 10:12 p. m., and passing it at 11 we stood to the southward along the coast until 3:35 p. m., October 11, when we put over the hand lines in 20 fathoms, gray sand, S. 32° W., 10½ miles from the light-house at Shoalwater Bay. Failing to take anything after a trial of 15 minutes, we ran a line S. 78° W., 20 miles, sounding in 38, 51, 153, and 432 fathoms; S. 68° E., 15 miles, in 98, 55, and 40 fathoms, and S. 78° W., 15 miles, in 60, 78, and 260 fathoms, the last sounding being taken at 11:48 p. m. The wind was from the eastward during the forenoon, varying from light to moderate, but during the evening it hauled to SE., and at midnight it was blowing a moderate gale with rapidly rising sea, which forced us to cease work and heave to under steam, head to the wind.

Tradition places extensive banks about 50 miles off the Columbia River bar, which, if they exist, would doubtless afford valuable fishing grounds. The object of our explorations was not only to locate and examine these banks if they were found, but to ascertain the species of fish inhabiting the regions adjacent to the coast, their abundance, and the best methods of taking them. The gale continued from SW. to WNW., during the 12th, with heavy confused sea, moderating, however, during the evening. We were hove to, head to wind, until 5 p. m., when the vessel was put before it for the remainder of the day.

Coast of Oregon.—Cape Disappointment light was sighted at 2:45 a. m., October 13, Tillamook light at 3:30, and at 6:53 we cast the lead in 73 fathoms, N. 64° W., 16½ miles from Tillamook light, and ran a line S. 72° W., 15 miles, sounding in 82, 96, and 199 fathoms; N. 15° E., 15 miles, in 174 and 601 fathoms, and N. 85° E., 16 miles, in 102, 75, and 68 fathoms at the end of the line. At 2 p. m. the trawl line was set, and a successful haul of the trawl was made, No. 2882. The trawl line came up with 1 black-cod and a number of dogfish. The swell was still heavy, making boat work as well as handling the trawl rather difficult, but both were accomplished without accident.

At 4:40 p. m. we cast the lead in 81 fathoms, N. 78° W., 12¾ miles from Cape Disappointment and ran S. 78° W., 20 miles, sounding in 231, 421, 475, and 506 fathoms. It will be seen by reference to the chart that the soundings on the last line are two or three times greater than depths found on parallel lines 7 or 8 miles distant. This great submarine trough is, probably, the ancient bed of the Columbia River.

The 14th was overcast, with rain, mist, and occasional fog banks during the morning. We took a pilot at 7:55, crossed the bar, and anchored off Astoria at 9:45 a. m. Fire was discovered in the port coal bunker

a few minutes before noon, but was extinguished in a couple of hours, after shifting several tons of coal. It was a slow and tedious process, as the fire was in the after end of the bunker, which was full of coal. It originated from an auxiliary steam pipe covered with a 3-inch manilla rope, which proved an insufficient protection under the pressure of coal stored around it.

Mr. F. C. Reed, State fish commissioner, and others interested in the coast fisheries called during the afternoon. Hon. J. H. D. Gray, Colonel Taylor, and other prominent residents of Astoria visited the ship on the 15th. In discussing the fisheries of the region it soon became evident that a belief in the existence of banks 50 to 60 miles off the Columbia River was quite general, but we were unable to trace its origin. Heceta Bank lies off the coast, in latitude 44° 00′ N., longitude 124° 50′ W., and may possibly have had something to do with it. The explorations of the *Albatross* developed over 600 fathoms in the region where the banks were supposed to lie, but they may be found further south, as the region between the Columbia River and Hecĕta Bank is still unexplored.

The sea fisheries off the Columbia were commenced a few years since with a small schooner which operated a 40-foot beam trawl over the ground between Cape Disappointment and Shoalwater Bay. The vessel being found unfit for the purpose, the steamer *Dolphin* was built and made 40 trips between April and October, 1887, but she also proved a failure. Her catch was fairly good, and had she been able to market her fish promptly the venture would have turned out profitably. The various fish taken by the *Dolphin* were classified as follows, viz: Sole, flounders, hake, cod, rock-cod, and halibut. Very few cod and halibut were taken, sole predominating, although at times rock-cod were abundant. Crabs and a few large clams were also taken.

Judge Swan left us on the 16th and returned to Port Townsend.

We left Astoria at 10:35 a. m., October 18, and at 2:55 p. m. set the trawl line off Tillamook Rock, where Captain Richardson of the lighthouse steamer *Manzanita* reported having taken red rock-cod (called grouper in Astoria) in great numbers and an occasional halibut. We found nothing but dogfish on the trawl lines, showing that the coast of Oregon as well as that of Washington is infested by them during the fall months. Three hauls of the dredge were made in the vicinity over hard sand bottom with occasional rocky patches, and although few specimens were taken there are indisputable evidences that the region about Tillamook is an excellent fishing ground at certain seasons of the year.

Heceta Bank.—At 7.30 a. m. on the 19th, the trawl line was set in 50 fathoms, rocky bottom (No. 2886), on Heceta Bank. The dredge was lowered, developing a "live bottom" similar to that found on the best fishing banks. Two attempts were made to haul the beam trawl, but the net caught on the rough, rocky bottom and was wrecked on both occasions. The trawl line when hauled contained single specimens of

halibut, black-cod, shark, and dogfish. We ran lines of soundings across the bank to the westward, then to the southward and eastward, defining its extent, and at 2:20 p. m. lowered the trawl in 277 fathoms, No. 2890, making a successful haul.

Heceta Bank has not been fully developed, but from our present knowledge it may be said to be about 20 miles in length and 10 miles in width, its center lying in latitude 44° 04′ 00″ N., longitude 124° 53′ 00″ W. It has a rocky bottom, alternating with patches of clay and pebbles, and presents every requisite for an excellent fishing bank, which it will undoubtedly prove at the proper season of the year.

The weather during the 18th and 19th was all that could be desired, but indications of a change were unmistakable during the afternoon of the latter day, which ended with a moderate breeze from WNW. It increased rapidly, until at noon of the 20th there was a moderate gale from the northward and westward, with a heavy following sea. We did not feel it much, however, as we were running directly before the wind, under steam and sail. Cape Mendocino was passed at 2:12 p. m., and Point Arenas at 12:15 a. m., October 21. Point Reyes was abeam at 8:34, and, after passing it the wind died out and the sea moderated. Passing Duxberry Reef at 11 a. m., we stood down through Bonita Channel, entered the Golden Gate, and at 12:40 p. m. anchored in San Francisco Bay, off the foot of Washington street.

COAST OF SOUTHERN CALIFORNIA.

Preparations for the southern cruise.—The terms of service of many of the crew having expired, they were discharged and their places filled by new men, only a few of the old men reshipping.

The work of overhauling and refitting for the winter cruise commenced immediately after our arrival in San Francisco, and was carried on by our own crew as far as possible. We went to the Union Iron Works November 14, where such work as could not be done on board was taken in hand. It was completed December 11, and on the following day we returned to our former berth off the foot of Washington street. The specimens collected during the Alaskan cruise were forwarded to Washington on the 26th of November through the quartermaster's department, U. S. Army.

Prof. Charles H. Gilbert, ichthyologist, joined the ship on the 25th of December, in time to complete the necessary preparations for the cruise. The vessel was docked at the Union Works on the 26th, her bottom cleaned and painted, and was floated off on the morning of the 28th when we steamed to the Green street wharf for coal, took on board $122\frac{1749}{2240}$ tons, and then anchored in the stream. Our preparations for the southern cruise were completed by the arrival of the paymaster's stores from Mare Island, on the 2d, and at 2 p. m., January 3, 1889, we left the harbor and steamed to the southward. The weather was boisterous, and later in the day the wind increased to a moderate gale

from the southeast, with misty, rainy weather, and a heavy head sea. The ship was under half power as usual, using one boiler with the grate surface reduced to 45 square feet, and the consumption of coal being limited to 10 tons per day.

Santa Barbara Channel.—It was our intention to commence work off Point Sur, but arriving in that vicinity at meridian the following day we found it still too rough to handle the trawl with safety; so in order not to lose time we continued our cruise to the southward. At 6:45 a. m., on the 5th, we cast the trawl in 236 fathoms, Point Conception bearing N. 82° E. (true), 12 miles distant, and ran a line of dredgings across the channel to Richardson's Rocks, and thence to the west end of San Miguel Island. The trawl was set off the west end of the island on the rocky bottom, but only four rockfish were taken; the bait generally remained untouched. Several hauls of the tangles were made while the line was down, but without much success, the bottom being very barren. A heavy westerly swell which gradually increased during the day, made boat work very uncomfortable, so we lay to under San Miguel for the night.

The wind and sea moderated, and at 7:30 the following morning a successful haul of the trawl was made in 367 fathoms, S. 15° E. (true) 11 miles from Richardson's rocks. The trawl line was set at 10 a. m. in 197 fathoms on rocky bottom, a number of red rock-cod and four black-cod being taken, the first obtained so far south. A successful haul of the beam trawl was made in 158 fathoms while the line was out, and it was lowered again in 44 fathoms, but caught on the rocks and the wreck of the net only recovered.

The sea being comparatively smooth during the afternoon and the sun shining brightly, we availed ourselves of the opportunity to swing ship under steam for compass errors. Our nearest card, taken at Cape San Lucas, was found to be in error on several points. We made a harbor for the night in Becher's Bay, at the east end of Santa Rosa Island, where good anchorage was found, protected from the prevailing northwesterly wind but open to the eastward. The naturalists were on shore soon after daylight the following morning, returning at 11 a. m. with birds, a small fox indigenous to the island, and other specimens, among which were several human skulls and bones, one skeleton being nearly perfect. Professor Gilbert reported a great number of ancient human remains exposed on a strip of drifting sand 200 yards in width, extending from Carrington Point to the sea, a distance of about three-quarters of a mile. The only implements seen were stone mortars, which were scattered over the surface in great numbers, all broken, evidently by design, for they were too solid to have been fractured by accident.

Getting under way at 11:45 a. m., we ran a line of dredgings across Santa Barbara Channel, and although very many interesting specimens were found near the shores on either side, the deeper waters near mid-

channel, where the bottom is composed of soft green mud, were almost barren of life. We lay to for the night within range of Point Conception light, and at daylight set the trawl line near the shore, but caught nothing of consequence. A line of shoal-water dredgings was then run to the southward, which developed considerable life, but no "live bottom." The total absence of life on the surface was notable, and it would seem that the season alone is not sufficient to account for it. The presence of petroleum, which may usually be seen forming a thin film over the surface waters of the channel, may have something to do with it. We were enveloped in a dense fog from 7 a. m., but working along shore, where our course could be checked by soundings, it did not delay us materially, and half an hour after dark we anchored off Santa Barbara for the night.

Professor Gilbert went on shore early on the following morning and arranged with Capt. A. Larco to make a trip with us among the islands. He is the principal fisherman of Santa Barbara and has followed his calling in that vicinity for 18 years. Being an intelligent and observing man, he is probably better posted regarding the fisheries of that channel and islands than any other one on the coast. An accident to the machinery prevented the trip at this time and forced us to go to San Diego for repairs. Leaving the anchorage at 1:37 p. m., we arrived at our destination at 11:55 the following morning, January 10, when arrangements were made for immediate repairs to the disabled engine.

Alamitos Bay and Newport Harbor.—Professor Gilbert and Mr. N. B. Miller took advantage of the delay to examine some of the most promising localities on the southern California coast for the acclimation of oysters. They went first to Alamitos Bay, where they found, January 12, a surface temperature of 60° Fahr., depths 6 to 12 feet, bottom of sand and mud, the specific gravity ranging from 1.011948 to 1.023187. The presence of fresh water was apparent at all stations and the conditions would remain practically the same during the rainy season.

Newport Harbor was examined the following day and the surface temperature found to be 60° Fahr., specific gravity from 1.01520 to 1.02400, sandy bottom, with little or no mud. An examination in both the wet and dry seasons would be necessary in order to obtain a knowledge of the average condition of the waters throughout the year.

Cortez Bank.—Repairs on the engine having been completed, we left port on the 15th and ran a line of soundings from the whistling buoy, off Point Loma, to Cortez Bank, developing a series of elevations and depressions over which the depths varied from 211 to 1,047 fathoms. Arriving at the bank the following morning, we commenced investigations by sounding, dredging, and the use of hand lines. The sea was breaking heavily over Bishop's Rock, which made an excellent landmark, enabling us to locate ourselves on any part of the bank with certainty and without loss of time.

The examination was completed on the evening of the 17th, and

the general results may be stated as follows. The charts are on scales entirely too small to admit of details being shown. Bishop's Rock, on which there is but 10 or 12 feet, is the shoalest part of the bank. The sea breaks over it heavily during moderate weather, but with a smooth sea, when facing the sun, it can not be seen at any distance and is at such times very dangerous. The depths correspond generally with those on the charts, with the exception of a 6-fathom spot which was found about a mile south and east of Bishop's Rock. This might have led to a less depth, but there was a heavy swell at the time, which induced us to seek deeper water. Our soundings extended the area of the bank in a southwest direction, where it requires further examination. The bottom was composed of sand, shells, coral, and rock, the latter cropping out at short intervals over the entire surface. The fauna was very rich and varied. Fish were swarming over the bank in great numbers, and, in fact, it was found to be the richest ground we have found in the Pacific.

The trawl line was set and quite a number of fish taken, but the bottom was too rough for that method of fishing. Dangerous seas will be encountered on the bank in stormy weather, and heavy swells with moderate winds, but it is of small extent, and with the deep water surrounding it not an unusually dangerous fishing ground.

Starting from the northern end of the bank a little after dark on the evening of the 17th, we ran a line of soundings in the direction of San Nicolas Island for 12 miles, in depths less than 200 fathoms, 59 fathoms being found at 18 miles. This we marked for future investigation and continued our course to the island.

San Nicolas Island to San Diego.—We anchored off the east end of San Nicolas at 7:15 a. m., and landed a party of naturalists, who returned at noon with several additions to our collection, although the region was found to be rather barren of life. They labored under the disadvantage of collecting in half a gale of wind, the air filled with fine sand, and most of the small birds hidden from view. Evidences of a former population, in the shape of skeletons and broken stone mortars, were found in spots where they had been exposed by drifting sand.

Increasing wind and sea made boat work impracticable, so, to utilize the time, we got under way and ran a line of soundings to San Clemente, and thence to the region of Point Loma, where we arrived at daylight the following morning. The wind moderated as we approached the mainland, rain squalls ceased, and the sun rose bright and clear, revealing the snow-crowned mountains in the interior. The day was spent in deep-sea explorations, after which we steamed into San Diego and anchored. We were occupied during the 21st and 22d in overhauling the sounding and dredging gear, and some small repairs were made in the engineer's department.

Tanner Bank to San Clemente Island.—Everything being in readiness, we left the harbor at 7 a. m., January 23; made several hauls with the

trawl during the day, and finally, just before dark, anchored in Smuggler's Cove, San Clemente Island. Our objective point was the locality where, on a previous trip, we unexpectedly found a depth of 59 fathoms, and our anchoring was for the purpose of waiting the most favorable opportunity for exploring what we rightly conjectured to be an entirely unknown bank.

A gill net was set soon after anchoring and taken in at 3:20 a. m. with nothing in it, although fish were frequently seen at the surface during the night. The water was unusually phosphorescent, and the net, being anchored in a slight current, "fired" badly; that is, its position was indicated by a phosphorescent glow on the water, which was probably sufficient warning for the fish to keep clear of it.

Getting under way at 4:15 a. m., we ran a line of soundings from the island, finding a maximum depth of 807 fathoms. Reaching the 50-fathom line early in the morning, we spent the day in developing the bank, which may be described as follows:*

Its greatest length inside of the 50-fathom curve is 8 miles east and west (magnetic) by 2 miles in width at its eastern extremity, narrowing to 1½ miles at the western end. The center of the bank, on which was found 48 fathoms, is in latitude 32° 43′ N., longitude 119° 10′ W., and the least water, 28 fathoms, was found near the eastern end, in latitude 32° 42′ 30″ N., longitude 119° 07′ 15″ W. The bottom is composed of sand and shells, with numerous rocky patches, on which the fauna was found to be identical with that of Cortez Bank in similar depths. The 50-fathom curve on the east end lies north (true) 16 miles from Bishop's Rock, both being on the same submarine plateau, with intervening depths of less than 300 fathoms. The same species of fish found on Cortez were taken on this bank, and it may be considered a valuable addition to the fishing grounds of the Pacific coast.

We finished the examination at 11:20 p. m., and anchored off the southeast end of San Clemente at 7 a. m. on the 25th, when the naturalists were given a day on shore and along the beaches. A party of fishermen belonging to a San Diego sloop were encamped on the island. They fish with lines in from 30 to 40 fathoms, taking fat-heads, rock-cod, whitefish, etc., which they split and salt, large tubs being provided for the purpose. They use short trawl lines at times, but that is not their usual custom. Spiny lobsters or crayfish are taken in pots and kept alive in a car till the arrival of their sloop, which calls every week or 10 days for the catch, taking it to the San Diego market.

Los Coronados to Point Fermin.—We were under way at 10:30 p. m., and at daylight on the 26th cast the trawl in 623 fathoms off Los Coronados. Six hauls were made during the day from the above depths to 20 fathoms between the islands. Hand lines were used at several sta-

* This bank has been named "Tanner Bank" by the Superintendent of the U. S. Coast and Geodetic Survey, in honor of its discoverer. It was first designated on the U. S. C. and G. S. Chart No. 601, edition of 1889.

tions and a general examination was made of the fishing grounds in that vicinity. Later in the day we steamed into the harbor of San Diego, where we found the U. S. steamer *Ranger* and Coast Survey steamer *Hassler* at anchor. We went to National City for coal on the morning of the 29th and returned on the 31st, having taken on board 136 tons of Wellington coal.

An accident to the electrical machinery detained us until the morning of February 4, when, at 8:25 a. m., we got under way and proceeded to sea. Commencing at a depth of 45 fathoms off Point Loma, we ran a line of soundings to the vicinity of Point Fermin over ground which had not been examined and where we expected to find uneven bottom, judging from the charts of the vicinity and our own experience. Much to our surprise, however, the depths increased regularly to 464 fathoms, and then gradually decreased as we approached the latter point.

Several hauls of the trawl were made during the day. A thick fog shut down soon after midnight, and in order to verify our position we anchored until the weather cleared, about 10 a. m., when we got under way and commenced the examination of a reported shoal off Point Fermin. The day was spent in dredging, sounding, and hand-line fishing. Our own soundings and information gained from the fishermen at work on the ground led us to the belief that no shoal exists.

South Bank, so called by the fishermen, may be described as follows: It extends about 10 miles SE. by E. (magnetic) from San Pedro lighthouse, and is from 3 to 3½ miles in width. The depths increased regularly to 20 fathoms 2 miles from the point, and to 29 fathoms at the outer extremity. The soundings correspond generally with those of the Coast Survey chart, and the bottom was usually the same dark-gray sand; but putting the trawl over, it frequently dragged over stony patches, on which kelp, sponges, bryozoans, etc., were growing. Fish in paying quantities are found on the patches, or "spots," as they are called, red rock-cod, fat-heads, whitefish, etc., being taken at all seasons of the year.

The islands and channel off Santa Barbara.—At 5 p. m., having finished the examination of the bank, we started for Santa Barbara under low speed, arriving at 6:45 the following morning. Capt. A. Larco, the fisherman before referred to, came on board at 8 a. m., and an hour later we got under way for the islands. On heaving the cable in we found that the anchor had become unshackled, so the spot was buoyed, and we continued on our course, bending the sheet anchor for use during the trip. Steaming across the channel to the east end of Santa Cruz Island, a couple of hours were spent in the vain attempt to find a shoal spot discovered by Mr. Larco. The remainder of the day was occupied in sounding, dredging, and fishing in the channel between Anacapa and Santa Cruz. The eastern or Anacapa side had "live bottom," and is a favorite fishing ground, while on the opposite side the bottom consisted of clean sand with little or no life.

We anchored at 5:52 p. m. in Smuggler's Cove, Santa Cruz Island, where excellent protection was found from the prevailing coast winds.

There is quite an extensive ranch near the cove, with olive and fig orchards, a vineyard, large meadows, cattle, sheep, etc. We remained at anchor during the forenoon of the 7th, giving the naturalists an opportunity to investigate the shore line. The fishermen were particularly successful with the gill net.

Getting under way at 12:30 p. m. we took three hauls of the trawl off the south side of the island, and at 6:15 anchored in Becher's Bay at the east end of Santa Rosa. Two of the hauls of the afternoon, Nos. 2947 and 2948, in 269 and 266 fathoms, were among the richest of the cruise, a great variety of specimens, including 4 black cod, being obtained. The latter were rather under the medium size, but their flesh was excellent in flavor, nearly, if not quite, equal to those taken off the Oregon and Washington coasts. The deep-water sole is another excellent fish found here, and ranks among the best sea fishes on the Pacific coast, far superior to any that reach the Santa Barbara or San Diego markets.

We were under way at daylight on the morning of the 8th, and ran a line of dredging and fishing stations through the channel between Santa Rosa and Santa Cruz, and thence several miles along the crest of a submarine ridge which extends in the direction of San Nicolas. A fishing party had been sent out before we left the island, and as they were not prepared for a long absence from the ship we were obliged to return and pick them up, leaving the further exploration of the ridge to some future time.

A line of dredging and fishing stations was run along the south side of Santa Rosa during the afternoon, and at 4:40 we anchored under the southeast side of San Miguel. The character of the bottom differed from that of the previous day's investigations, it being clean hard sand, with frequent sharp rock projections, which made havoc with the nets. It was also barren of life, very few specimens being taken. A party of naturalists landed to explore the island, and a fishing party went out under the direction of Captain Larco, returning a little after dark with a good catch.

Getting under way at daylight on the morning of the 9th, we steamed towards Richardson's Rocks, which lie off the western end of San Miguel. A dense fog came rolling in before we reached there, and threatened for a time to interfere with our work, but finally passed off, and we arrived at our working ground without further delay. A line of fishing stations was occupied between the rocks and San Miguel, via Watson's Rock, and a party was sent out under the direction of Captain Larco to investigate localities inaccessible to the ship. We met with ordinary success only until passing Watson's Rock, where fish were found in great numbers, a thousand pounds or more being taken in less than 2 hours. Several successful hauls of the trawl were made

in the channel during the afternoon, and at 7:50 p. m. we anchored off Santa Barbara.

We left our anchorage at 7 a. m. on the 11th, and, piloted by Captain Larco, examined a fishing bank, the center of which lies E. ½ N. (magnetic) about 3 miles from Santa Barbara light-house. It is about a mile in length NE. and SW., by half a mile in width, soundings regular, with depths from 12 to 20 fathoms, fine black sand, with frequent stony patches or spots, on which there is a live bottom.

Another bank was examined and found to be between 2 and 3 miles in length, E. by S. and W. by N. (magnetic), and almost 1 mile in width, its center being 5 miles ESE. from the light-house. The soundings were regular with depths from 26 to 29 fathoms, which agreed closely with the Coast Survey chart, as did those on the bank previously examined. The bottom was sandy, with frequent stony patches, as before described.

The stones were composed of hardened clay, filled with holes, easily crumbled in the hand, and strongly resembling the tosca of South American coasts. It was covered with kelp, sponges, bryozoans, and other marine growths. The lead did not give the true character of the bottom, and it was ascertained by dragging the trawl or tangles between stations, stony patches, some of them very small, being encountered every two or three ship's lengths. Kelp was found growing on all of them, much of it being brought up by the trawl, the roots still adhering to their stony ballast. It seemed to be a young growth, as none of it reached the surface. According to Captain Larco, these banks were at one time alive with fish, but being so near the harbor, they were soon fished out, and are visited now only by rowboats or sailing craft too small to go to the islands. There are no indications of these rocky or stony patches on the Coast Survey charts.

Later in the day, a small rocky patch, marked on the chart 4 miles south (magnetic) from the light-house, was partially examined, and muddy bottom, with rocks and coral patches, was found in from 50 to 60 fathoms. It was not known to the fishermen of Santa Barbara, but Captain Larco was confident that it was a spot on which, many years ago, an old Indian used to fill his canoe when others failed to catch anything on the known banks.

We anchored off Santa Barbara for the night, and at 5:30 the following morning got under way and steamed to the west end of Anacapa Island, for the purpose of extending our exploration of the fishing grounds between it and Santa Cruz, but a strong wind sprung up suddenly, with furious squalls, which obliged us to abandon boat work and confine ourselves to the use of the trawl. A line of stations was occupied along the south side of Anacapa, where the bottom was found to be rough and rocky, tearing the nets and affording but few specimens. The wind moderated before noon, and standing in for the east end of the island we put the hand lines over but caught nothing. A Chinese

junk was seen near by, standing off and on under the lee of the land, trying for fish, and as they had no better success than ourselves we left the ground, steaming 11 miles SSE., in the direction of San Nicolas, and cast the trawl in 603 fathoms, green mud, making an excellent haul. Several new species of fish besides other specimens were taken.

San Nicolas Island to San Diego.—A line of soundings was run to San Nicolas during the night, and several fishing stations were occupied early on the morning of the 13th, with the intention of carrying them around the island, but the weather became so boisterous that we were obliged to give it up. A line of soundings was then run to Santa Barbara Island, the greatest depth found being 649 fathoms, and a haul of the trawl was made *en route*, but increasing wind and sea forced us to anchor under the lee of the island. The collectors were landed and made several additions to their list of birds, in spite of wind and dust. A fishing party was sent out also, but met with indifferent success.

The prospect the following morning was not reassuring. The gale was still increasing, and, as nothing could be done where we were, a line of soundings was run to Santa Catalina Island, developing a depth of 718 fathoms. It was our intention to anchor under the lee of the island, and give the naturalists an opportunity of seining on the sheltered sand beaches of Catalina Harbor, but we found the sea rolling in too heavily and with every prospect of continued bad weather, so we started at once for San Diego under steam and sail, arriving at 7 p. m. the same day.

THE REVILLA GIGEDO ISLANDS, LOWER CALIFORNIA, AND THE GULF OF CALIFORNIA.

San Diego to Guadeloupe Island.—We took on board 121 tons of coal on the 23d and 25th, and, all preparations having been made for a trip to the southward, got under way at 1:15 p. m., February 26, and steamed out of the harbor. Standing for Los Coronados we passed between the islands, and 4 miles to the southward commenced a line of soundings in 76 fathoms, carrying it to the island of Guadeloupe. The depths increased regularly to 804 fathoms at 33 miles, and 856 fathoms at 81 miles from the first station, then to 1,856 fathoms 30 miles from the island. It will be observed that our soundings extend the submarine plateau in a southerly direction, but the rocky elevations which occur so frequently to the westward were not encountered.

The island was sighted at 9:30 on the morning of the 27th, at a distance of 60 miles, the mountain peaks being seen above the mist which enveloped the lower levels. Approaching it in the evening, the weather or western side was covered with a dense fog, while to the leeward it was comparatively clear. The water was smooth, and not caring to seek an anchorage during the night, we lay to till daylight, when we stood in for a harbor on the south end of the island. The wind was so fresh that we were forced to return to the lee side, where an anchor was dropped in 17 fathoms, and a party of collectors sent out. The fisher-

men reported very poor success, having seen but few fish about the rocks, and little or no life upon the bottom, which was covered with gulf mud. The shore collectors did not fare much better, and, in fact, the region was barren and unprofitable. The vessel got under way and made several hauls of the trawl during the forenoon in shoal water. At 12:30 p. m., the naturalists having returned, we stood further off shore and made a haul in 684 fathoms, followed by several more in shoaler depths. There was much rocky bottom, which tore the nets without giving us much in return.

The island of Guadeloupe is 14½ miles in length, from 3 to 5 miles in breadth, and is of volcanic origin, lava cliffs and huge bowlders being visible on all sides. Its greatest height is 4,523 feet. There is some wood and fresh water on the northern portion of the island, but no practicable anchorage occurs at that end. It is inhabited by people who have large flocks of goats, which they raise principally for their skins.

Guadeloupe Island to Alijos Rocks.—At 5.30 p. m. we started for Alijos Rocks, running a line of deep-sea soundings en route, and developing a maximum depth of 2,165 fathoms. Reaching the rocks on the morning of March 2, several hauls of the trawl and dredge were made over a rough coralline and rocky bottom, which made sad havoc with the nets and yielded very few specimens. The hand lines were put over without results. Los Alijos, as they are usually called, are a group of rocks surmounting a volcanic elevation, and extend about half a mile north and south, and less than a quarter of a mile east and west. There are four rocks above water, the southernmost being 112 feet in height, the northern one 72 feet, and the other two but a few feet above the sea. There was quite an area over which the sea broke very heavily. The rocks are entirely barren, their vertical sides preventing the possibility of landing, even if the surf permitted a near approach. The tops of the higher rocks were covered with sea birds. Traditions of a large seal rookery led us to the vain hope that the practically extinct sea elephant of the California coast might have survived in this remote region. There was no sign of them, however, and in fact there were no rocks accessible to these animals that were not swept by every huge sea which constantly broke over them. The rocks are fast crumbling away through the action of the water.

Alijos Rocks to Clarion Island.—We left the Alijos at 10:30 a. m. for Clarion Island, carrying the line of deep-sea soundings, which reached a maximum depth of 2,280 fathoms, 170 miles from the rocks, nearly midway between them and the island. An occasional petrel was seen, and tropical birds, boobies, etc., were of frequent occurrence. Scattering flying fish were observed from time to time, where, in the summer, the surface is fairly alive with them.

The mountain peaks of Clarion Island were made at 9:30 on the morning of March 4, at a distance of 41 miles, and at 4 p. m. we anchored in Sulphur Bay. Collectors were landed to look over the ground and

fishing parties sent out in boats. The naturalists with large parties detailed from the ship's company were out at daylight the following morning, and explorations both ashore and afloat were vigorously prosecuted. It was virgin soil practically, and the results so important that we decided to remain another day. After the collectors had left the ship the next morning we got under way and spent between 7 and 8 hours with trawl and dredge. Lava bowlders were found strewn over the bottom, making it very difficult to haul the trawl or even the dredge. There was comparatively little life found, but such specimens as we secured were of sufficient value to induce us to persevere. Returning to Sulphur Bay at 4:30 p. m., the collectors and fishing parties were taken on board, and a few minutes later we started for Socorro.

Clarion Island is uninhabited, and from its isolated position almost unknown. It is a volcanic elevation about 6 miles in length, and from 1 to 3 miles in width, rising from a depth of 2,000 fathoms to an altitude of 1,282 feet above the sea, and with minor peaks of 996 and 916 feet. The shores are steep and rockbound, with the exception of two open bays on the south side. Sulphur Bay, the westernmost, has fair anchorage, but the other has much foul ground, breakers extending beyond the outer points. A sand beach several hundred yards in length lies at the head of Sulphur Bay, but between it and deep water a rocky ledge, just below the surface or awash at low tide, causes a heavy surf and makes a landing there impracticable. Our boats landed on the rocks inside of East Head, but the best landing was found in a small cove west of West Head, not more than half a mile from the anchorage.

Fresh water was found in two small lagoons near the beach in Sulphur Bay, where thousands of sea birds lined the shores, wading along the shallow margins or skimming lightly over the surface. Sir Edmund Belcher reported these lagoons to be salt, and as fresh water was of the greatest importance in his day, and the first thing sought for in strange lands, there can be no doubt concerning the accuracy of his report. They are near the beach, but little above the sea level, and it may be possible that a southerly gale would force sufficient sea water into them to make the water brackish. That they are fresh for a considerable portion of the year is evidenced by fresh-water algæ and other forms. It rained quite heavily during the night of our arrival, and next morning small rock pools were seen, but a day or two of sun would evaporate them.

The lower portions of the island are covered with lava bowlders, large and small, and between them is an impenetrable growth of cactus (prickly pear), through which a passage must be cut in order to reach the interior elevated plateaux. Quite large areas of these mesas were covered with a luxuriant growth of grass, and dense clumps of stunted bushes were seen here and there, which could be utilized as firewood in case of emergency. A vine was quite common, with blossoms resembling the wild pea, and there were about half a dozen flowering plants,

specimens of which were preserved. Both land and sea birds were very plentiful. Among the former were the raven, wren, snipe, stilt, dove, and owl. Sea birds literally covered the ground and bushes in certain localities, the man-of-war hawk, tropic bird, and three species of booby being the most numerous. A snake was seen on shore, and one or two green turtles in the surf, but none were captured. Grasshoppers, mosquitoes, and spiders were plentiful, and several species of the latter as well as many specimens of a species of lizard were secured.

The waters around the island were swarming with fish, of which 46 species were taken, 20 at least being edible, and several were seen that we failed to capture. Sharks abounded in great numbers, and whenever we lowered a boat from three to half a dozen were on hand to look it over and follow it. If a line, large or small, was thrown over from the rail they were ready to take it, and if by chance a smaller fish succeeded in capturing the bait there was a race between fishermen and shark for the prize, the latter getting his full share, including hooks and lines. Another source of loss was attributable to the fish themselves, several species having small mouths armed with powerful teeth, with which they snapped off the hooks when taking the bait. The method we found to be most successful was to fish in comparatively shoal water, where the bottom and the fish near by could be distinctly seen. Then by careful watching and dexterous manipulation of the line we were able in a great measure to select our species.

Leaving Sulphur Bay we steamed around the west end of the island, passing Monument Rock, a remarkable formation 200 feet in height. Its massive rectangular base is surmounted by a shaft, nearly square, composed of alternate strata of red and white rock.

Clarion Island to Socorro Island.—Deep-sea soundings were continued, developing a depth of 2,012 fathoms 80 miles from the island, a little more than a third of the distance to Socorro. We made the latter island on the evening of the 7th, and steaming toward it under low speed during the night, arrived in Braithwaite Bay soon after daylight, March 8. The naturalists, with large parties of volunteers and details from the crew, left the ship soon after we anchored, some of them landing, others fishing from boats and seining.

Socorro is the largest island in the group, being about 9½ miles in length and 8 in breadth. The central peak reaches an elevation of 3,707 feet, and its general features are identical with those of Clarion Island. We found no fresh water except in small rock pools, the largest not exceeding a gallon, the result of recent rains, which would be evaporated by two or three days' exposure to the sun. Unmistakable evidences of the existence of numbers of goats were seen in tracks and beaten trails on every hand, but the animals themselves were not visible. Doubtless they were feeding in the vicinity of water, and visited the east end of the island only when heavy rains replenished the rock pools before mentioned sufficiently to furnish them a supply. The fer-

tile areas in the elevated mesas are much greater in extent than those of Clarion Island, and were covered with an equally luxuriant growth of grass, affording excellent pasturage. The surface was smooth, and walking a pleasure after toiling through the almost impassable region of bowlders and cactus on the lower levels. Dense clumps of bushes were frequently encountered, and in sheltered spots groves of cottonwoods were seen, some of the trees reaching a height of 30 feet or more.

The vine producing the bean on which Captain Colnett's men became so sick was seen in bloom. There were two species of grass, and about half a dozen flowering plants. We saw no sea birds on the island and very few on the wing, which was a surprise after our experience at Clarion. Six species of land birds were taken: a large red dove, ground robin, wren, hawk, thrush, and a night heron. Two species of lizards, from 4 to 7 inches in length, were the only reptiles seen. Flies, mosquitoes, and butterflies were found, but no beetles or spiders, both of which were plentiful on Clarion Island.

Fish were very plentiful, 44 species being taken, 14 of which were not found at Clarion; 30 were common to both of the islands, and 20 species from each place were edible. Many of them were unknown to Professor Gilbert, and nearly all were new to me. Quite a number of chub mackerel were taken with hook and line at night by the aid of the submarine light; two or three other species that would not take the hook in the daytime were captured in the same manner. Humpbacked whales were constantly in sight during our stay at Clarion Island and Socorro, quite a number of calves being seen at the latter place.

Socorro Island to San Benedicto Island and Cape San Lucas.—At 3:10 a. m., March 10, we left Braithwaite Bay for San Benedicto Island, about 30 miles distant, directly on our route to the Gulf of California. The greatest depth, 1,635 fathoms, was found about midway between the islands. Anchoring off the east side of the latter at 9:45 a. m., the collectors were landed and a fishing party sent out.

San Benedicto, like all others of the group, is of volcanic origin, about 3 miles in length, one-half to three-quarters of a mile in width, and 975 feet in height, irregular in form, concave on the east side, and, including the outlying rocks, convex on the west side. The southern end is the highest, and is the half of a volcanic cone composed of pumice stone, with an occasional mass of dark-red lava rock. The mountain has been separated in the middle, the western half left standing, while the other portion has entirely disappeared, exposing the interior of the crater. The island has usually been reported as a barren rock. Its surface is irregular, and on the lower levels there is little vegetation; but there are elevated mesas on which a luxuriant growth of grass was found, the succulent "bunch" grass, so highly prized by stock men, and a rank, woody-stalked variety, growing from 3 to 5 feet high, and so thick that it was not an easy task to walk through it. Cactus is one of the chief products of the islands of the group, yet it was not observed on San

Benedicto. It may, however, exist in small quantities. There was neither wood, water, nor even a bush seen on the island; but it was the home of thousands of sea birds, man-of-war hawks and three or four species of booby being the most numerous. A raven and rock wren were the only land birds found; and there were very few insects, grasshoppers and spiders being the only ones seen. Fish were abundant, the species being identical with those of Socorro.

The sailing directions mention a small shingle beach as the best landing, but other portions of the island are inaccessible from it, so our collectors landed on the rocks north of the beach at the foot of the bluff, from which point they had free access to the plateaus on either hand. Whales, old and young, were constantly in sight near the island. The collectors returning at 2 p. m., we got under way for the Gulf of California and carried our line of soundings to the vicinity of Cape San Lucas, the greatest depth, 1,807 fathoms, being found 22 miles from the island.

Hydrographic conclusions.—Reports of islands, rocks, and reefs in the regions recently traversed by the *Albatross* have been current from time immemorial. The U. S. S. *Narragansett's* investigations resulted in their being expunged from the charts, but she gave us no information regarding the contour of the ocean bed, which is really the only sure method of deciding the existence or non-existence of submarine elevations. This gap has been filled by the soundings of the *Albatross*, which prove definitely that these vigias do not exist in the positions assigned them.

Another important problem has been solved. The chain of islands commencing with Guadeloupe and extending to Los Alijos and the Revilla Gigedo group have been considered as a submerged mountain range, extending parallel with the peninsula, connected with it by a submarine ridge at one extremity and, previous to the submergence, inclosing a gulf similar to the Gulf of California. The *Albatross* soundings not only show this to be an error, but demonstrate the fact that the several islands are isolated volcanic elevations entirely independent of the continent and of each other, the sea reaching its normal depth between each of them, and also between them and the peninsula.

La Paz to San Josef Island.—We entered the gulf on the evening of March 11 and arrived at Pichilingue Bay, the United States coaling station, at 11:24 a. m. the following day. An officer was sent to La Paz to call on the United States consul, Mr. James Viosca, and the following morning I visited him and with him made official calls on the military governor and captain of the port. A lighter was towed from town by the steam cutter, and the work of coaling commenced immediately on our arrival. We finished coaling on the afternoon of the 15th, having taken on board 90 tons.

Getting under way at 7:30 on the morning of the 16th, we steamed to the northward through La Paz Bay, and at 11:03 cast the trawl in 112 fathoms, green mud, Balleñas Island bearing E. by S. (magnetic) 4 miles.

There were but few specimens taken, and the tow net demonstrated the entire absence of life on the surface.

The trawl was cast again at 1:26 p. m. in 211 fathoms, midway between Espiritu Santo and San Josef Islands, and as in the previous haul few specimens were taken. The lead rope was loaded with seaweed having the offensive odor of decaying organic matter. The character of the bottom in this region is represented as rocky by the Hydrographic Office chart, and judging by the appearance of the arming on the lead, which was indented without bringing up a specimen, we would have confirmed it, but the trawl showed a perfectly smooth bottom, and the presence in the net of two or three small pieces of compact sand revealed the true nature of the soil. Another haul of the trawl was made in 40 fathoms, sand and broken shells, between San Josef Island and the mainland, in which the same offensive weed was found and very little else. The tow net showed an almost total absence of life on the surface.

Arriving off Salinas Point, San Josef Island, at 4:40, we landed a fishing party, which made several hauls with the seine while the ship was engaged in dredging. The oyster dredge was used, and outside of 20 fathoms very few mollusca were found, but in from 10 to 12 fathoms the ground was literally covered with living and dead shells, having a sprinkling of pearl oysters among them. At 5:50 p. m. we came to for the night in Salinas anchorage, the fishing party returning a few minutes later.

Getting under way at daylight the following morning, we steamed to the entrance of a salt-water lagoon, near the northwest end of the island, which we were informed in La Paz was the best place on the west side of the gulf for oysters. Two boats were sent in charge of Professor Gilbert to investigate the matter, and returned in about 2 hours, bringing specimens of mangrove oysters. These have small, round shells, with fluted edges, and are very salt and bitter, with a slight coppery taste. While they might be considered edible, they are inferior to the poorest wild oysters on the Atlantic coast. The temperature of surface and bottom was 71°; specific gravity, 1.027764, a little above the average of sea water.

San Josef Island to Carmen Island.—Continuing our course to the northward, a haul of the trawl was made at 12:30 p. m. in 362 fathoms, green mud. The bottom was very soft, the net taking in an enormous load of mud, which required much time and patience to get rid of before it could be landed. There was a large number of deep-sea cusk taken, the haul being remarkable for the absence of other forms of life usually found at that depth.

At 7:15 p. m. we anchored in Salinas Bay, Carmen Island, which is an excellent harbor during northerly winds, although open to the southward. The submarine electric light was put over during the evening, attracting a school of mackerel. Quite a large number were taken with hook and line, but their flesh was found to be dry and lacking in flavor.

Seining and fishing parties were sent at daylight next morning with the expectation of finding rich working ground, but to our surprise very little life was found in the bay. Scattering specimens only were taken in the seine, and the line fishermen met with no success. Long-shelled oysters have been reported, but we found none, and the inhabitants knew nothing of their existence.

Carmen Island is justly celebrated for its salt pond, which is one of the most remarkable formations of its kind on the continent and is profitably worked nothwithstanding high freights to San Francisco and the duty imposed by the United States Government. The pond is oblong in form, covering an area of about 5 square miles, its nearest approach to the sea being a third of a mile. It has no surface connection with the gulf, but at high tide sufficient water percolates through the sand and shingle barrier to maintain the general level. Standing on the shores one sees before him a solid mass of pure white salt, its myriads of shining crystals glistening like a field of diamonds under the rays of a semi-tropical sun. The salt is deposited in strata from 4 to 6 inches in thickness at the surface, increasing to 12 inches at 15 feet, the greatest depth to which the bed has been examined. Between the strata are spaces of 1 to 2 inches, filled with water and black mud, which is doubtless the earthy impurity precipitated during the process of evaporation. The method of collecting the salt is simple and inexpensive. Men with crowbars break from the surface pieces of convenient size, which are loaded into mule carts, transported to the shore, and piled in large masses to dry, after which it is ready for shipment. The space from which salt is taken fills with water, and the process of evaporation begins at once, a few weeks only being required to replace the quantity extracted. In fact, so rapid is the work of reproduction carried on under the cloudless skies of the gulf that, although thousands of tons are removed annually, a small portion only of the surface is ever disturbed.

Carmen Island to Conception Bay and Guaymas.—We were under way at 3:10 p. m., and an hour later cast the trawl in 306 fathoms, soft green mud. An enormous load of mud was brought up in which was found quite a number of deep-sea cusk, but no other life. It had the same offensive odor before mentioned.

At daylight the following morning, March 19, we entered Conception Bay, and at 7:15 anchored off the north part of Coyote Bay. Seining and fishing parties were sent out among the islands, but fish were scarce and the few seen about the rocks would not take the hook. The region was so unpromising that we got under way at 1:45 p. m. for Mulegè, anchoring off that place at 2:50. A seining party met with good success in the mouth of the river, returning with a boat load of fine fish of various species. It was the first place on the west shores of the gulf where we found fish in large numbers, and the Mulegè River being the only fresh water encountered the natural inference was that fish

would be found in quantities only at or near the mouths of streams. Leaving Mulegè at 2:05 a. m. on the 20th, a line of soundings, serial temperatures, and specific gravities was run across the gulf. The trawl and surface net were put over at two stations in 857 fathoms and 1,005 fathoms, and the submarine electric light was used with success during the evening.

Cape Haro light was sighted at dark, and at 11:20 p. m. we came to in the outer anchorage of Guaymas, moving to the inner harbor on the morning of the 21st. We were boarded by the captain of the port soon after anchoring, and an hour later by the United States consul, Mr. Alex. Willard, who has ably represented the Government at that port for 22 years. A large mail awaited our arrival. Official visits were exchanged with the military governor, prefect, and others, all of whom expressed great interest in our work, and a desire to assist us in every way possible. The naturalists were busy about the shores of the bay during our stay in port, adding a number of species to our list of fishes, several varieties being procured from local fishermen and from the market.

Guaymas to the mouth of the Colorado River.—We left Guaymas at 7:40 a. m., March 23, steaming to the northward, and at 2 p. m. a haul of the trawl was made in 71 fathoms, gray sand, 16 miles WNW. (magnetic) from San Pedro Nolasco Island. Three more hauls were made during the afternoon at intervals of one to two hours over the same character of bottom, the depths decreasing to 14 fathoms. They were all very rich in the number and variety of fish taken, and other forms were more plentiful than on the western shores.

A sounding, serial temperatures, and specific gravities were taken in the channel between Estaban and Tiburon Islands in 89 fathoms, and at 5:30 a. m., March 24, the observations were repeated in 145 fathoms, Rock Point, Angel de la Guardia Island bearing WSW. ¾ W. (magnetic), 18.5 miles distant. A successful haul of the trawl was made at the last station, followed by seven casts during the day, the last one being off George Island, where at 9.30 p. m. we anchored in 13 fathoms, the south end bearing NE. ½ E. (magnetic), about a mile distant. Collectors and fishing parties left for the island at daylight, returning at 8:50 with a few fish and sea birds. The fishermen were more successful on board, having taken a large number of squeteague and a species of sea bass, an excellent fish weighing from 60 to 160 pounds, besides other species with which I was not familiar. The island was found to be a barren, guano-covered rock, on which were many sea birds and a rookery of sea lions.

Getting under way on the return of the boats, we steamed across George's Bay, anchoring at 11:25 a. m. off the entrance to a lagoon, Rocky Point bearing WNW. ½ W. (magnetic), 6 miles. A seining party was sent in, but returned several hours later, much disappointed at the barrenness of the region. We were more successful on board

ship, however, many fine fish having been taken, the species identical with those of George Island. The entrance to the lagoon is hidden at the distance of a few miles by low rocky ledges nearly awash at high water, the channel lying between them and the shore. Our boats found no difficulty in crossing the bar at half tide. We were under way again at 3:15 p. m., steaming to the northward. Four hauls of the trawl were made during the evening, the surface net being put over at each cast, and at 9 p. m. we came to in 19 fathoms for the night. We were in the open gulf with no immediate protection by land, yet the sea was perfectly smooth and the vessel as quiet as though she had been securely moored in the snuggest harbor in the gulf.

It was foggy from 2 to 4 a. m., on the 26th, with drizzling rain, and the land was obscured at daylight, but we felt our way with the lead, finally anchoring at 7:20 a. m. 3½ miles below Shoal Point. Collectors and seining parties were sent on shore, returning at 1 p. m. with a few birds and fish, but they reported the region almost barren of life. We were under way again at 3 p. m., made three hauls of the trawl over a clean, sand bottom with but little life, and at 4:55 anchored in 11 fathoms, Direction Hill bearing N. W. ⅜ N., 7.5 miles distant. Trial lines were put over, and large numbers of squeteague and sea bass were taken. The former averaged about 10 pounds in weight, and the latter ranged from 70 to 150 pounds. So many were taken that I was obliged to put a stop to the fishing. A gill net was set during the evening, but was soon wrecked by a shark which dashed in to secure a squeteague already enmeshed. Sharks and dogfish were found throughout the gulf in sufficient numbers to make gill-net fishing impracticable. The region about our anchorage was examined with a view of detecting the presence of shad, but the seine, beam trawl, and gill net failed to capture a single specimen.

Colorado River to Guaymas.—The fishermen having returned to the ship, we got under way at 3:20 on the morning of the 27th and steamed to the southward in the direction of Consag Rock, taking soundings, serial temperatures, and specific gravities at intervals of 8 or 10 miles. The results will be found in the table accompanying this report. Arriving off the rock at 7 a. m., three hauls of the trawl were made in the vicinity, while the naturalists were examining the shores. A soft, gray mud filled the trawl net to such an extent that much time was consumed in landing it after some of the hauls. The naturalists found but little life on or near the rocks, and the fish paid absolutely no attention to a baited hook. Consag Rock is conical in form, entirely barren, and is the resort of sea birds and sea lions.

At 8:30 we steamed to the southward, taking an occasional haul of the trawl, the mud of the bottom becoming softer and more barren as we approached the western shore. An excellent anchorage in 7 fathoms was reached at 6:15 p. m. off the south side of San Luis Island. The western portion of the island is composed of dark-red lava rock, while

its sea face and the large rock to the eastward of it are solid masses of pumice-stone. Large numbers of sea lions were seen on the rocks to the northward of our anchorage, and whales and porpoises were plentiful, but the latter seemed very wild. The collectors were out at daylight the following morning, returning at 8:10 with fish, turtles, etc. Three sea lions were brought in and skinned, and two skeletons prepared. As soon as the boats were hoisted we steamed into Willard Bay and anchored at 10:35 a. m. in 6 fathoms, sand and mud. Fishing parties and shore collectors left as soon as the anchor was down.

Willard Bay is not shown on the gulf chart, and as it is a safe anchorage, entirely protected from all winds except from the southward, and partially protected even in that direction, we made a reconnoissance of it during the day, which is sufficiently accurate for purposes of navigation. The position of the observation spot is reliable, having been located by equal altitudes of the sun for longitude, and ex-meridian and meridian altitudes for latitude, the artificial horizon being used. The lagoon mentioned in Hydrographic Notice No. 6, 1889, is a bay opening to the sea north of the island forming the north and east sides of Willard Bay, the two being connected by a narrow channel through which boats can pass at half tide. It was dry at low water. The seining parties were fairly successful, and the line fishermen found many fish about the rocks, but they would not take a hook. The collectors were out again at daylight on the 29th, returning at 9 a. m., when we got under way, skirted the southern shores of San Luis Gonzales Bay to Cape Final, thence across Balleñas Channel to Puenta Refugio, Angel de la Guardia Island, where we arrived at 3:15 p. m. and anchored in 7¾ fathoms.

The sailing directions mention Puenta Refugio as being noted for iguanas and rattlesnakes. We saw none of the former, but found many lizards on the low land near the bay, the specimens procured measuring from 14 to 18 inches in length. It was early in the season for rattlesnakes, yet two were captured near the beach. The collectors returned at 5 p. m. with a variety of shoal-water specimens and a couple of seals, besides the lizards and rattlesnakes before mentioned. Whales were in sight most of the day, and about noon we passed within a mile or two of a dead one, on which thousands of birds were feasting. Getting under way, at 5:25 we steamed out of the eastern entrance en route for Guaymas. Puenta Refugio is an excellent harbor, entirely protected except from northerly and easterly winds, and Granite Island affords partial protection in that direction. The latter island, as its name implies, is a solid mass of excellent granite.

At 12:30 a. m., March 30, we entered the channel between Tiburon and San Estaban Islands, doubled Cape Haro at 3 p. m., and came to in the inner harbor of Guaymas at 3:55 p. m. The United States consul visited the ship, and in the evening General Julio M. Cervantes, military governor, with a large number of gentlemen, came on board and examined

specimens, apparatus, and the vessel itself. They were particularly interested in our explorations in the gulf, and examined the various specimens with great interest, expressing surprise at the variety of marine fauna which they had never seen nor heard of before. The submarine electric light attracted much attention.

Guaymas to Cape San Lucas; study of oyster beds.—The naturalists were out at daylight on the 31st, returning at 7 a. m., and half an hour later we left the harbor for the oyster grounds about the Yaqui River. At 9:45 a haul of the trawl was made in 20 fathoms, mud, and an hour later we came to off the entrance to Algodones Lagoon, from which most of the oysters sold in the Guaymas market are obtained. There was about 5 feet of water on the bar at low tide, and from 5 to 20 feet in the lagoon. The temperature of the water was 69° F., specific gravity 1.026508.

Oysters of excellent quality were found in abundance on banks, and in clusters scattered about the bottom, which was composed of sand and mud, most of them being exposed at ordinary low water, and all of them at spring tides. The oysters were about the size of those found in Chesapeake Bay, perhaps a little smaller, plump, and fat, of excellent flavor, and compared favorably with the wild Raccoon oysters of the Atlantic Coast. Indians collect them by hand, transport them to Guaymas in canoes, and sell them for $1 per 1,000.

San Juan Lagoon lies between Algodones and the Yaqui River. The depth of water is about the same, the temperature 70° F., and specific gravity 1.026808; bottom, sand and mud. The beds were more extensive than at Algodones, and the oysters ran about the same size, but were not so fat or of as fine a flavor.

An examination of the Yaqui River was made on the afternoon of April 1. Fresh water extended to the bar and flowed into the gulf in large volumes. There were no indications of oysters inside of the bar, not even dead shells. Myriads of sea birds were gathered on the beaches and extensive sand bars. A couple of Indian fishermen anchored in the brackish water just outside of the bar and, with the crudest fishing gear, in less than 2 hours, loaded their canoe with jewfish and large sea bass. Trial lines were put over from the ship at her anchorages off the lagoons and river mouth, taking many catfish. The collectors returned at 5:15 p. m., when we got under way and steamed to the southward, anchoring at 8:53 a. m., the following day, off a lagoon or estero, about 3 miles north of Rio del Fuerte. Fish were found in great abundance, squeteague, Spanish mackerel, and mullet being among the most numerous.

The naturalists returned to the ship at 4 p. m., and the time allotted for explorations in the gulf having expired, we got under way for La Paz, where we arrived at 8:30 on the morning of April 3. The United States consul visited the ship, and with him I called on the military governor, who, with his staff, returned the visit during the afternoon.

The ship was thrown open to visitors and large numbers availed themselves of the opportunity to see a vessel of which they had heard so much. We left the harbor at 6:15 the following morning with two coal lighters in tow, arriving in Pichilinque Bay at 7:40. Coaling commenced soon after and continued with slight interruptions until the morning of April 6, when we had received 95 tons, sufficient for the return trip to San Francisco. Getting under way at 9:05, we returned the lighters to La Paz, made final preparations for sea, and left the harbor at 1:25 p. m. for Cape San Lucas, arriving at 12:10 p. m. the following day. Fishing and seining parties went out as usual, returning at 4 p. m., having met with little success. A few fish were taken with the seine, and great numbers were seen around the Frailes, but they refused the hook. The run from La Paz to Cape San Lucas was made with one boiler, using the coal recently taken from the naval station at Pichilinque Bay, and although the sea was smooth we found it impossible to make more than six or seven knots an hour. This speed would have been reduced to four or five knots after reaching the Pacific, with the coast winds and swell to contend with, so time being an important element, we lighted all fires for the first time since our arrival in Bahia, December 19, 1887.

Cape San Lucas to San Francisco.—We left San Lucas Bay at 4:20 p. m., and encountered a moderate head wind and sea after rounding the Frailes into the Pacific. Two hauls of the trawl were made off the entrance to Magdalena Bay the following morning in 31 and 47 fathoms, and at 12:46 p. m. we anchored in Man-of-War Cove, off the village of Magdalena. The collectors went out at once, returning at dark fairly successful, although the variety of fish was not so great as we were led to expect from various reports. Information was received that excellent oysters could be found in the bay, but on investigation it was ascertained that they were the mangrove oysters, growing about 40 miles to the northward, near Boca del Soledad.

The collectors were out at daylight on the 9th, and at 1 p. m. we got under way, picked up one of our seining parties, and made several hauls of the trawl, in which many flounders and other species of fish were taken, finally anchoring again at 4:30. The collectors returned an hour later after a successful day's work, when we got under way and proceeded to sea. The U. S. Coast Survey steamer *Gedney*, en route from the Atlantic to San Francisco, was sighted as we left the bay. Moderate head winds and seas were encountered during the night and following day. Three hauls of the trawl were made in 74, 58, and 181 fathoms.

At 7:15 a. m., on the 11th, we anchored in San Bartolome Bay, where we found the U. S. S. *Ranger*, which had arrived from San Diego the previous evening. Fishing and seining parties were sent out during the day, but met with indifferent success, although the bay is reported to be an excellent fishing ground. The officers and crew of the *Ranger* made three hauls of the seine, the first being practically a water haul,

the second resulting in the capture of a half-dozen green turtles and a few fish, the third and last haul surprising all hands by bringing in 162 green turtles, some of them of enormous size, besides two or three dozen fish of various species.

Seining parties were out at daylight on the 12th, returning at 8 a. m. The *Ranger* left the harbor at 5, and at 8:50 the *Albatross* got under way, steamed through Dewey Channel, and at 1:30 p. m. came to in an open bay to the northward of Marro Redondo, Cerros Island. Shore collectors and a seining party left the ship, returning at 3:45, when we got under way for San Quentin. The usual coast wind and swell were encountered during the night, and at 11:30 the following morning we anchored off Entrada Point. A seining party was sent into the bay, and hand lines were put over the rail, taking large numbers of smelt, some of them measuring 14 inches in length. The boats returned at 3:55, and we left immediately for San Martin Island, anchoring off Hassler Cove at 5:50. A seining party left the ship, returning at 7:45, after several successful hauls on the beach. We left San Martin at 8 p. m. and steamed to the northward during the night. The dry, clear weather of the Southern Peninsula and Gulf of California was succeeded by frequent squalls and drizzling rain, which continued at intervals until meridian on the 14th, when we passed Los Coronados, and at 2:45 p. m. arrived in the harbor of San Diego.

The Coast Survey steamer *Gedney* arrived on the morning of the 17th. Mr. C. H. Townsend left for a trip to the mountain regions of the peninsula of Lower California, and on the following day Prof. C. H. Gilbert and Mr. A. B. Alexander left the ship under orders from the Commissioner to proceed to Yuma, and from that place as a base, to make explorations in the Colorado and Gila Rivers for the purpose of ascertaining the existence of shad in those streams. The specimens taken during the winter's cruise were shipped through the Quartermaster's Department, U. S. Army, to the Fish Commission in Washington. We remained in San Diego several days to paint ship and attend to other work that could be advantageously executed in that excellent harbor.

COASTS OF WASHINGTON AND OREGON.

Preparations for the cruise.—At 3:45 p. m., April 22, we left San Diego for San Francisco, arriving at 2:10 a. m. on the 25th, after a moderately smooth and uneventful trip. The Russian corvette *Kreysser* and Coast Survey steamers *Hassler* and *Gedney* were lying in port, and joined this vessel in dressing ship in honor of the centennial of Washington's inauguration on the 30th of April. The *Kreysser* fired a national salute of 21 guns at meridian.

Senators Hale and Allison visited the ship May 8, and inspected her quarters with a view to accepting her services for the purpose of transporting to Sitka the Senate committee, of which Senator Hoar was chairman. They seemed favorably impressed with the vessel and promised to report to the committee at once.

The *Albatross* remained at anchor, the crew being busily engaged in giving her a general overhauling, until the afternoon of the 9th, when we got under way and steamed to the U. S. light-house station, where, through the politeness of the inspector, Commander Nicoll Ludlow, U. S. Navy, we were allowed to stow a number of spare articles, which we were desirous of getting out of the vessel in order to give us a much-desired increase of room in the holds. From the light-house station we went to the Union Iron Works to put new boilers, just received from the Herreshoff Manufacturing Company, in the gig and cutter; to dock and paint the ship's bottom, and make necessary repairs which could not be effected by our own crew.

The Senate committee formally accepted the services of the vessel on May 11 to take them to Sitka. It was stipulated that we would meet them at Victoria, British Columbia, on May 28, and return to Seattle or Tacoma June 7, the committee to pay the expenses of the trip. The early departure of the vessel in order to reach Victoria at the appointed time necessitated the utmost dispatch in our preparations for sea. She was docked and painted on the 14th and 15th. Paymaster's stores were received from Mare Island on the 18th, and the installation of new boilers in the steam cutters was completed the same evening. Other repairs were sufficiently advanced for our own men to complete them. We left the iron works at high tide on the 19th, anchoring in the harbor until the following morning, when we went to the wharf, took on board 69½ tons of coal besides various stores, and at 5 p. m. anchored in the stream. Professor Gilbert and Mr. Alexander returned to the ship on the 21st from their expedition up the Colorado and Gila Rivers.

San Francisco to Seattle.—We were ready for sea on the morning of the 21st, and at 12:50 p. m. got under way and left the harbor en route for Departure Bay, British Columbia. Passing Point Bonita at 2 p. m. we reached Point Reyes at 6:27, the wind and sea increasing until at midnight there was a moderate gale from NW., with a heavy head sea. This moderated during the 22d and 23d, and on the 24th the wind was light and variable, with a smooth sea. We passed the Columbia River during the forenoon of the 24th, and at 12:30 a.m on the 25th doubled Cape Flattery and entered the Straits of Juan de Fuca. The weather was overcast and foggy, lighting up at intervals until 4 a. m., and then a dense fog shut down till 7 a. m., when we ran out of it and had clear, pleasant weather during the remainder of the day. Passing Race Island light at 6:10, we steamed through Haro Strait, Swanson Channel, Active Pass, and the Gulf of Georgia, arriving at Departure Bay at 2:25 p. m. Going to the wharf at 3:15 we commenced coaling at once. Work was resumed at 5:30 the following morning, and we left the wharf at 3:15 p. m., having received 144¼ tons. Leaving the harbor half an hour later we entered Active Pass at 9:17, and at 10 anchored in 10 fathoms in Miners' Bay. The weather was overcast at midnight, with moderate southerly winds and frequent showers of rain. We were under way at

4:15, and at 8:10 a. m. anchored off the steamer wharf in the outer harbor of Victoria. An officer was sent to call on the U. S. consul, who visited the ship at 10:30 a. m.

Final preparations were made, and at 4 p. m. the vessel was ready for sea. The Senate committee arrived at 6 p. m., and when called upon informed us that it had become necessary to change their plans and abandon the contemplated trip to Alaska. Having nothing further to detain us we left Victoria at 5:30 on the morning of the 29th and anchored in Port Townsend at 9:45, when inquiries were made concerning supplies ordered to meet us there, but they had not arrived. We went to Seattle the following morning and remained until June 6, waiting for alcohol, making some repairs in the engineer's department, and attending to other matters which were left unfinished on our hurried departure from San Francisco. The consignment of alcohol failing to arrive, a small quantity was purchased in open market, and we left port for a cruise off the coasts of Oregon and Washington Territory. We called at Port Townsend on our way down the sound to get a dory for fishing purposes, but could find none for sale.

Coast of Washington.—Getting under way from the latter place at 11:30 a. m., we entered the Straits of Juan de Fuca an hour later, encountering a fresh head wind and chopping sea, which reduced the speed considerably, as we were using only one boiler. We passed Cape Flattery at 10 p. m. and, although the wind had moderated, a heavy swell still rolled in from the westward, knocking the ship about uncomfortably, our course placing her in the trough of the sea.

At 9:10 a. m. on the 7th we cast the trawl in 48 fathoms on the bank off Shoalwater Bay, and spent the remainder of the day in exploring the bay, the beam trawl, trawl line, and hand lines being used. Flounders and red rock-cod were the principal fish taken and they were fairly abundant, although not sufficiently so to warrant an attempt to take them on a large scale. Scattering dogfish and skates were taken on the trawl line and many of the baits were covered by starfish. Whales were seen on the bank during the day.

Coast of Oregon.—At 4 p. m. we started to the southward, passed within range of Cape Disappointment and Tillamook Lights, and at 3:18 a. m., on the 8th, were abreast of Yaquina Light. Taking our departure from the point, we ran for Heceta Bank, where we arrived at 8:50 and sounded in 46 fathoms, rocky bottom. A trawl line was set and the beam trawl put over, but it caught on the rocky bottom and wrecked the net. The tangles being substituted, several hauls were made, bringing up gorgonian corals, sponges, bryozoans, crinoids, pennatulas, ophiurans, starfish, sea-urchins, etc., which indicated live bottom. In addition to the trawl line, which was set as soon as we reached the bank, trial lines were used from the ship at intervals, and boats were anchored at different parts of the bank, from which hand lines were used. Each method was fairly successful, large numbers of red rock-cod and orange

rock-cod being taken, besides scattering specimens of yellow-tails, dog-fish, etc. The red rock-cod are plentiful, and a well-conducted fishing vessel could take them in large numbers.

Leaving the bank at dark, a line of soundings was run to Yaquina Head, developing a maximum depth of 78 fathoms. At 6.55, on the morning of the 9th, we cast the trawl in 28 fathoms, fine gray sand, Yaquina Head bearing east (magnetic) 27 miles, seven species of flounders being taken, besides crabs, shrimps, etc. A fishing party was sent out in a boat, but met with no success. We then steamed off shore, keeping the light-house on the same bearing, east (magnetic), and repeated the trials in 43 fathoms, coarse gray sand, taking large numbers of flounders in the trawl, the line fishermen being equally successful with orange rock-cod. Wind and sea increased during the morning, finally becoming too rough for boat work, so to utilize the time we ran in and anchored under Yaquina Head, where the ship was partially protected, and sent a fishing party out in a boat to examine the shore line to leeward of the rocks. The party returned after several hours' work without a fish, and no better success attended the use of hand lines on board ship.

Leaving our anchorage at 2:30 p. m., we made two hauls of the trawl in 38 and 77 fathoms, the trial lines being put over at the former station without result. The trawl was landed on deck at 8 p. m., and we then started for Tillamook Rock, our next point for investigation. The wind and sea were so heavy that we did not reach the rock till 10:20 the following morning, and then it was too rough for boat work; in fact, the indications were so unfavorable that we ran for Astoria, where we anchored at 3 p. m. the same day. We learned on our arrival of the burning of the business portion of Seattle, the fire having occurred on the afternoon of the 6th, a few hours after we left the harbor.

The light-house steamer *Manzanita* made an ineffectual attempt to land supplies at Tillamook on the 11th, and left the harbor again at 3:30 a. m., June 13, in company with this vessel. Arriving at the rock, the former made fast to her moorings and commenced landing supplies for the light-house, while we set a trawl line across the channel inside of the rock, made three hauls of the trawl, and used the hand lines from the rail. The trawl line, with 700 baited hooks, remained on the bottom four hours, taking one halibut and one large skate. Many of the hooks were covered by large starfish, but the majority of the baits remained untouched. Three halibut and a ground shark were taken with hand lines from the *Manzanita* while lying at her moorings. Specimens taken with the beam trawl included eight species of flounders, hake, tomcod, sculpins, shrimp, smelt, crabs, an octopus, etc., while a few red rockfish were caught with the trial lines.

We left Tillamook at 11:15 a. m. for Cape Flattery. Three hauls of the trawl were made during the afternoon in 46, 27, and 55 fathoms between the rock and Cape Disappointment, the character of the fauna being similar to that found off Tillamook in the same depths. Trial lines were put over at each station without result.

Coast of Washington.—A sudden and marked change in the color of the water was observed after we passed Cape Disappointment, the light green of the region off Columbia River giving place to a dark olive-brown strongly resembling the cypress water of the Virginia and Carolina swamps. It became somewhat lighter as we approached the coast near Cape Flattery, but off shore and on the banks south of Vancouver Island it still retained the peculiar tint described, which seemed to indicate its northern origin.

The weather became overcast and misty after dark, and at midnight we were enveloped in a dense fog, through which we groped our way to the halibut bank off Cape Flattery, where, at 10:27 a. m., on the 14th, we sounded in 31 fathoms, gravel and broken shells, and set a trawl line. Trial lines were put over the side whenever the vessel was lying still, taking several red rock-cod and a halibut weighing 93 pounds. The trawl line was allowed to remain on the bottom about 3 hours, taking 8 halibut, 10 red rock-cod, 1 cultus-cod, and a few scattering specimens of other fish. This result, considering that the line was set without previous trials, indicated the presence of large numbers of halibut and rock-cod and very few dogfish, only 3 or 4 having been taken.

The boats returned at 2 p. m. and, the fog being still very thick, we felt our way into Neeah Bay for a harbor, intending to continue our work as soon as the weather favored us. The 15th brought no improvement, the indications being so unpromising that we considered it advisable to return to the sound, and leaving our anchorage at 4.20 a. m. we arrived at Port Townsend at 2 p. m., where we found a quantity of supplies awaiting us. After taking them on board we steamed to Seattle, where we arrived at 6:40 p. m. The city front presented a most desolate appearance, nearly 100 acres having been burned over. The hundreds of busy men seen clearing the wreck next morning, preparatory to rebuilding, is an evidence of the push and enterprise of the people of this young and promising city.

We remained at anchor until the afternoon of the 18th, when we got under way and made a couple of hauls of the trawl in 82 and 135 fathoms off Dwamish Head. Among the specimens taken were several chimæras, three species of flounders, hake, skate, starfish, sea-anemones, shrimp, shells, etc., none of them in large numbers. Having finished dredging we anchored off Point Orchard and sent out a seining party, but they met with indifferent success. Fishing and seining parties were away during the forenoon of the 19th, and at Meridian we got under way and returned to Seattle.

A consignment of 6 barrels of alcohol reached Port Townsend, and on receiving information of its arrival we went there immediately and took it on board, intending to make a short cruise off the coast before going to the mines for coal. We were detained by unfavorable weather until 10:50 a. m., on the 27th, when we got under way and proceeded to sea.

Passing Cape Flattery at 10 p. m., we steamed offshore until 7:45 a. m. on the 28th, when the trawl was cast in 760 fathoms, green mud. A heavy westerly swell caused the ship to tumble about so much that it was difficult to carry on our work, and finally resulted in parting the bridle stops, causing the net to come up tail first, and practically empty. There were, however, a few pennatulas, starfish, holothurians, etc., adhering to the net. Four more hauls were made during the day in 636, 685, 584, and 477 fathoms, the bottom being uniformly of green mud. The wind and sea increased with heavy rain squalls, making it necessary to use the small trawl the latter part of the day, the weather being too boisterous to handle the large one with safety. The results were very satisfactory and, it being practically new ground, many unrecognized specimens were taken besides others that were familiar, among them being several species of flounders, deep-sea sole, Norway haddock, red rock-cod, macruri, chimæras, hag-fish, *Antimora*, and other small species. Among the invertebrates were shrimp, sea-urchins, holothurians, ophiurans, starfish, sea-anemones, crinoids, pennatulas, hermit crabs, annelids, etc.

The weather was partially overcast on the 29th, with moderate winds and heavy westerly swells. Three hauls of the trawl were made in 877, 859, and 178 fathoms, green mud, with excellent results. Among the fishes recognized were Norway haddock, flounders, sole, red rock-cod, and a single specimen of black cod taken in 859 fathoms, the greatest depth in which they have been found. Among the invertebrates were holothurians, sea-anemones, starfish, ophiurans, hermit crabs, an octopus, shrimp, annelids, sea-urchins, pennatulas, etc., the greatest amount of life being found in about 200 fathoms.

The stations occupied on the 28th and 29th extended our explorations from the shore to 877 fathoms, and gave us a very good representation of the marine fauna occupying the various depths. A notable feature in the hauls made during the trip was the absence of mud in the trawl net when it reached the surface, although soft green mud was reported at every station. This would seem to indicate that the bottom was composed largely of very fine sand, rather than mud, or at least the absence of clay. A few whales were seen, but with this exception no surface life was observed. The brown albatross and an occasional petrel were the only birds seen, except near the land, where gulls were plentiful.

The last haul of the trawl was finished at 5:28, when we steamed for Cape Flattery, en route for Departure Bay, British Columbia, for coal. Passing the cape at 10 p. m., we entered the Straits of Juan de Fuca, through which we steamed to Haro Strait, Active Pass, and the Gulf of Georgia, arriving at the coaling station at 3 p. m., June 30, where arrangements were made for coaling preparatory to taking the U. S. Senate committee on Indian Affairs to Alaska.

PERSONNEL.

The following officers were attached to the vessel June 30, 1889: Lieut. Commander Z. L. Tanner, U. S. N., commanding; Ensign Marbury Johnston, U. S. N., executive officer and navigator; Ensign Henry E. Parmenter, U. S. N.; Ensign Edward W. Eberle, U. S. N.; Ensign C. M. McCormick, U. S. N.; Passed Assistant Surgeon James E. Gardner, U. S. N.; Assistant Paymaster C. S. Williams, U. S. N.; Passed Assistant Engineer C. R. Roelker, U. S. N.

The civilian staff was constituted as follows: Prof. Charles H. Gilbert, naturalist; Charles H. Townsend, assistant naturalist; A. B. Alexander, fishery expert; N. B. Miller, assistant; H. C. Fassett, clerk to commanding officer.

REPORT OF A. B. ALEXANDER, FISHERY EXPERT.

[From January 1 to June 30, 1889.—Abstract.]

COAST OF SOUTHERN CALIFORNIA.

Santa Barbara Channel.—The second cruise of the steamer *Albatross* on the Pacific coast began January 3, 1889, but no work was done until the morning of the 5th, when the trawl was put over in the vicinity of Point Conception, California, in 225 fathoms. Among the specimens collected were 1 black cod or beshowe (*Anoplopoma fimbria*), 2 specimens of octopus, and 7 red rockfish. About 11½ miles farther southeast, the beam trawl was lowered in 284 fathoms and, while the dredging was going on, a cod trawl was baited with salt herring, 2 barrels of which were purchased in San Francisco. When fresh bait can not be obtained this salt fish is generally used by the fishermen at that place. At 1.15 p. m. the dingey left the ship's side and the trawl was set in 53 fathoms of water; bottom, broken shells and sand; Richardson's Rock bearing east, about 1 mile distant. After setting, we lay to and began fishing with hand lines, the ship dredging in the meantime. Several species of fish were taken in the beam trawl, but nothing was caught on the hand lines.

At the end of an hour we began to haul the trawl. The tide, which was running to windward, against a fresh northerly breeze, caused the dingey to "hawse up" considerably, however, and on several occasions large quantities of water were taken on board. It requires very little wind or sea to render the dingey unsuited for hauling a trawl, as boats of this class are so deep in the water that it generally takes the united strength of two men to pull it in. We had hauled but a short distance when the ground line parted, compelling us to row to windward and pick up the other buoy. We arrived on board the steamer at 3 p. m. with only four red rockfish.*

* This name is used to designate indiscriminately a large number of species of *Sebastodes*.

Early on the following day a trawl line of 500 hooks was set in 197 fathoms, Point Bennett, San Miguel Island, bearing NE. by N. ½ N., 3¼ miles distant. The tide was running to the SE. at the time and it was slack water when it was hauled. It was taken up after being down about an hour, and 4 black-cod or beshowe, 1 red rock-cod, and 2 ratfishes (*Chimæra*) were found on the hooks. We had had no information of the occurrence of the black-cod so far south, but judging from the short time the trawl was on the bottom, it is probable that the species might be captured in considerable numbers in this vicinity.

At 5:15 p. m. on the same day the *Albatross* anchored in Becher's Bay, Santa Rosa Island, and a cod trawl was immediately set in 20 fathoms of water, out in the bay towards Santa Cruz Channel. It remained down over night, and when examined the next morning had on it only 1 puffer shark (*Cephaloscyllium ventriosum*), 3 sea-anemones, and 1 crab. I had intended making a landing with the naturalists on Santa Rosa Island for the purpose of seining along the beaches, but as the surf was too heavy the project was abandoned.

On the morning of January 8, while dredging was going on, a trawl line was tried in a depth of 20 fathoms, rocky bottom, about 7 miles to the southward of Point Conception. Hand lines were also used from the ship and from the small boat at the same time, but no fish were taken with either kind of gear.

About 4 miles to the southward of Santa Barbara Light we ran into extensive "slicks" on the surface, caused by petroleum bubbling up through the water. Oil is frequently reported by the fishermen and sea captains in this vicinity, sometimes in small patches and at others covering large areas. Its prevalence in this region probably prevents migratory fishes from schooling in this part of the channel, and possibly may tend to influence their movements over a considerable distance both up and down the channel.

Cortez Bank.—January 16 we sounded in 60 fathoms on Cortez Bank (dredging station No. 2911, latitude 32° 27′ 30″ N., longitude 119° 05′ W.), where hand lines were put over, taking two red rock-cod and one whitefish (*Caulolatilus princeps**) in the course of about 15 minutes. A second trial was made soon after at hydrographic station 1621, latitude 32° 25′ 30″ N., longitude 119° 05′ W.; depth 17 fathoms; bottom rocky. Fishing was carried on with hand lines for 45 minutes, during which time the vessel drifted into 5 fathoms of water. The results were as follows: 17 fat-heads (*Trochocopus pulcher*), 10 yellowtails (*Sebastodes flavidus*), and 2 sea bass (*Serranus clathratus*). The strong and sharp teeth of the fat-heads played sad havoc with hooks and gangings, stripping the former from the snoods nearly as fast as they could be put on. These fish would be very destructive to trawl lines set across the rocky patches they frequent. The yellowtail rockfish would fol-

* I am indebted to Prof. C. H. Gilbert, naturalist of the *Albatross* during this cruise, for most of the scientific names of the fishes mentioned.

low to the surface any struggling captive at the end of a line; their movements somewhat resemble those of the Atlantic Coast pollock.

Having baited a trawl while the hand-line fishing was going on, we set it at 12:40 p. m. in 26 fathoms, hard bottom. It was allowed to remain down one hour, after which no little difficulty was experienced in hauling it, because many of the hooks caught on the bottom and it was necessary to break the hooks or part the gangings to recover it. When within about 10 fathoms of the end the ground line broke, and we were obliged to haul the remainder of the trawl from the other buoy. The result of the trial was 18 fish, as follows: 2 red rock-cod, 3 whitefish, 1 treefish (*Sebastodes serriceps*), and 12 fat-heads. We arrived on board the steamer at 3:55 p. m. While the trawl was down, dredging and hand-line fishing were carried on from the ship, the following species being taken by the latter: 39 fat-heads, 37 yellow-tails, 1 whitefish, 3 red rock-cod, 2 black rockfish (*Sebastodes mystinus*), 1 scorpion (*Scorpæna guttata*), and 2 jewfish (*Stereolepis gigas*). The two specimens of the last-named species weighed 155 and 190 pounds respectively. The fat-heads averaged 10 pounds each in weight. Fishing began in 25 fathoms and was carried into 8½ fathoms.

Cortez Bank was found to be the most promising offshore fishing ground on the California coast south of San Francisco. It has an area of 51 square miles, with depths less than 50 fathoms. The deeper parts of the bank have been surveyed to a slight extent only, but it is probable that good fishing will also be found outside of the 50-fathom line. The shoal part of the bank is about 15 miles long (WNW. and ESE.), its center being in about latitude 32° 26′ 30″ N., longitude 119° 08′ W. Bishop's Rock, which reaches to within 2½ fathoms of the surface, lies in latitude 32° 25′ 40″ N., longitude 119° 06′ 30″ W. A fishing vessel at anchor on the bank to windward of this rock would probably find it extremely uncomfortable if caught out in a heavy gale; but as the rock is small, a staunch schooner could work out by it into deep water, if not anchored too near it when the storm began.

Previous to the investigations of the *Albatross* nothing was known respecting the food-fishes inhabiting this bank. The demand for fish along this part of the coast is so limited at present that the fishermen do not find it necessary to venture outside of a few headlands in search of new grounds. They can give but little authentic information respecting the fishing grounds 25 to 30 miles off the coast. The fishing areas adjacent to San Diego and Santa Barbara are sufficient for the immediate requirements of those places, but with a considerable increase in population, more distant and deeper grounds will have to be sought for, necessitating the building of a larger and better class of fishing boats.

As ice is so expensive on the Pacific coast as to prevent its use by the fishermen to any great extent, it would be desirable, when an innovation is made in the fishing vessels of this part of the coast, to build small smacks of 15 to 25 tons burden. If constructed on the model of

the eastern well or smack boats, they could make quick and safe passages to and from Cortez Bank. A week or a fortnight could be spent, if necessary, in obtaining a fare, and by the end of that time fish would still be in good preservation, whereas the present methods compel the fishermen to market their fish daily to prevent their becoming unfit for sale. Several of the fishermen of the region have been interviewed on the subject, but they are not yet ready to make any change in their long-established customs. They now consider it only necessary to keep their fish protected from the sun, and to throw water on them occasionally. One fisherman asserted that he had tried a well smack unsuccessfully, as the fish invariably died soon after coming to anchor in a harbor; but upon being further questioned he acknowledged that he never bailed out the well at such times, an operation which is considered indispensable on the Atlantic coast. The water changes naturally in the well, when the vessel is under way, but there is no appreciable change when its progress is stopped, and frequent bailing is necessary to maintain its purity.

The abundance of edible fishes on Cortez Bank, of the same species which now find a sale in San Diego, Santa Barbara, and Los Angeles, indicates that the resources of this bank are sufficient to supply the southern California markets for some time. The deeper unexplored waters about the bank will probably also add to its importance as a fishing region, but the fishermen are not yet prepared to fish in depths over 100 fathoms, having no knowledge of hurdy-gurdies and other conveniences of the Atlantic coast.

Seventeen and one-half miles NNW. from Bishop's Rock is another small fishing ground discovered by the *Albatross*, which has been called "Tanner Bank" by the Superintendent of the Coast Survey. It has an area of about 17 square miles, and between it and Cortez Bank depths of 150 to 250 fathoms have been found.

January 17, sounding, dredging, and fishing were carried on continuously over Cortez Bank. Seven trials with the hand lines, from a quarter to half an hour in duration, were made during the day, resulting in the capture of 95 fish. The first was at hydrographic station 1631, 47 fathoms, where 1 white fish and 1 yellow-tail were caught. The second was at hydrographic station 1632, 26 fathoms, where 15 whitefish, 5 red rock-cod, and two fat-heads were taken. These fish ejected their food in coming to the surface, and their stomachs were empty when examined. One cultus-cod, 1 yellow-tail, 2 red rock-cod, and 1 whitefish were the total results of about 20 minutes' fishing at hydrographic station 1633, depth 43 fathoms. The fish took the bait less eagerly than on the preceding trials, and we observed that the vessel had drifted from places where we were hauling them "pair and pair" into others where not a single bite would be felt. The bank seemed to have many spots or ridges where all the species mentioned occurred in great abundance,

but on leaving these places good fishing stopped. The fishing greatly resembled that for red snappers in the Gulf of Mexico.

At hydrographic station 1636, 45 fathoms, no fish were taken. We were possibly drifting in a little gully, and a slight change of position to either side might have brought us over good ground. It frequently happens that in fishing for rock-cod off Cape Ann, Massachusetts, some boats may have excellent success while others only a few feet away will be unable to secure a bite. Twenty-two whitefish, 11 red rock-cod, and 3 fat-heads were subsequently secured in 20 minutes at hydrographic station 1639, 30 fathoms; and 11 fat-heads, 4 yellow-tails, 1 black rock-cod, and 1 scorpion (*Scorpæna guttata*), in a few minutes, at hydrographic station 1640, 11 fathoms. The last trial of the day was made shortly after dark at hydrographic station 1641, 51 fathoms, for the purpose of determining the effects of darkness upon the fishing. The results seemed to prove that the fish will not bite after dark, as we were in a good locality and could feel the fish constantly striking against our leads and lines. Not a single specimen was taken on the hooks, however.

San Nicolas Island to San Diego.—We arrived at San Nicolas Island early on the morning of January 18 and anchored a short distance offshore on the southern side. Soon after breakfast a seining party landed, but only two hauls were made on the beaches, a heavy sea filling the boats and tearing the seine on the second trial. An interesting collection of fishes, however, was obtained. While preparing to leave, a Chinese fishing boat rounded the point and anchored near us. This Oriental-looking craft was in search of abalone shells, which are found in great abundance on San Nicolas Island. The Chinese fishermen of San Diego and neighboring places do a lucrative business in gathering these shells and shipping them to the various markets of the Pacific coast.

The ship returned to San Diego January 19, and the following day numerous seine hauls were made in Spanish Bight, a small sandy bay on the southern side of the harbor. Nothing was taken worthy of special notice, although the net was tried in every available spot. The scarcity of fish may have been due to the state of the tide, which was ebbing at the time.

Tanner Bank; San Clemente Island.—On the morning of January 23 the ship again went to sea, and for 4 days dredging, sounding, fishing, and shore collecting were carried on without interruption. A line of stations was first run to San Clemente Island, an anchorage being made for the night in Smuggler's Cove on the south side of the island. During the evening a herring and a mackerel net were set a short distance from the ship. While doing so we noticed close by what appeared to be a small school of young herring, but on hauling the nets at 5:30 the next morning they were to our surprise entirely empty. It is possible that the school of fish observed was the only one that entered the cove that night, and the fish may have been too small to mesh in the

nets. The only reason that can be assigned for our obtaining no specimens was the exceeding phosphorescence of the water which caused the entire net, even to the foot line, to glow as with a bright flame, thus bringing it out into bold relief, and each time that the float rose and fell with the waves brilliant sparks would be emitted over a considerable distance. Phosphorescence always tends to warn fish against meshing in the gill nets at night, but in night seining, especially with mackerel, it is often of great assistance to the fishermen in locating the schools.

From Smuggler's Cove the ship proceeded to Tanner Bank. The shallow part of the bank was reached early in the day, and dredging and hand-line fishing were begun. The results were practically the same as on Cortez Bank, the species of fish being identical in the two localities, and not differing materially in their relative abundance. Fair fishing was obtained at hydrographic station 1679, 28 fathoms, rocky bottom, the catch consisting of 9 red-rock cod, 6 whitefish, 2 yellow-tails and one fat-head. Several other successful fishing trials were made during the day.

Early on the morning of the 25th the steamer anchored under the southeast end of San Clemente Island, and two parties were landed for the purpose of seining and shore collecting. One party, consisting of Professor Gilbert, six seamen, and the writer, landed on a long smooth sand beach, about 2 miles from the ship's anchorage. It was an excellent place for working the net, without a single rock in sight for a distance of at least a mile and a half, but the surf running somewhat heavily caused us a little trouble. Repeated hauls were made with the seine, and it is safe to say that we probably obtained representatives of nearly all the species of fish that were congregated along the beach at that time. In nearly every haul there were large numbers of the viviparous perch (*Holconotus argenteus*), together with a few "smelts." After the seining had been finished, the party made a brief examination of the island, securing, however, only two lizards as a result of the natural-history collecting.

Fisheries about San Diego.—On the morning of January 26 investigations were begun in the vicinity of Los Coronados Islands. The first trial for fish was made with hand lines at hydrographic station 1706, latitude 32° 25′ N., longitude 117° 18′ W., 51 fathoms, 5 red rock-cod and 1 fat-head being taken. The next fishing was done at dredging station 2931, 34 fathoms, latitude 32° 25′ 30″ N., longitude 117° 16′ 45″ W., and was a failure. These stations were between the North and South Coronados. A small Italian fishing boat was anchored close by where the last trial was made. She was on a favorite spot, but had met with poor success, the catch for the previous 24 hours having amounted to only about 50 pounds of red rock-cod, whitefish, and fat-heads. During the summer months these species are sometimes very abundant.

Such fish as are taken in the vicinity of Los Coronados and San Diego bring from 3 to 4½ cents per pound. Very few are salted by

the Italian fishermen, the salt-fish trade being monopolized by the Chinese. The Italians fish with both hand lines and line trawls, but chiefly with the former on account of their cheapness. Trammel nets are frequently used among the rocks close inshore, and fish that will not readily take the hook are often caught with them. A trammel net 30 fathoms long and 2½ fathoms or 40 meshes deep costs $25. A trawl of 500 hooks, completely rigged, and including the basket in which it is coiled, is valued at $5. Baskets are used on this coast for the storage of the trawls in preference to the tubs of the Atlantic coast.

The trawl hooks used by these fishermen are the same as those employed by the French fishermen on the Grand Bank and by the fishermen on the coast of Spain. The gob-stick is unknown, and when the fish swallows the hook, or is otherwise hard caught, a quick jerk of the ganging causes the hook to straighten out and it is then readily extracted. All such hooks have to be bent again to the proper shape before they can be used, but this is readily done during the baiting of the trawl by means of a knife, or of two small nails driven into a board about half an inch apart. By the latter method the point of the hook is placed against one of the nails and the bow over the other, when the bending is easily accomplished. A device of this kind is kept ready for use at all times, and the fishermen claim that it takes much less time to bend a hook than to replace it with a new one.

The best fishing about the islands is found between the Northern and Southern Coronados in 25 fathoms. Close to the southern side of the northern island the water is deeper, having an average depth of 45 fathoms. In this latter place red rock-cod are the principal fish taken. About 5 miles south of the southern island is a small shoal ground sometimes resorted to by San Diego fishermen. These two "spots" are the only offshore fishing grounds known in the immediate vicinity of San Diego.

The Italian fishing boat previously referred to was a primitive affair about 18 feet long, 7 feet wide, and 2½ feet deep, with a flat bottom. The greatest breadth was at the stern. The sleeping and eating quarters were very wretched, consisting of the bottom of the boat, among nets, trawls, hand lines, buoy lines, old anchors, rusty iron kettles, and other implements. An iron kettle was used as a stove, somewhat after the manner of the French Canadian fishermen of the Gulf of St. Lawrence. The hand lines employed were as rudely constructed as some of those made by the Alaskan Indians. Many sizes of lines were noticed with pieces of lead attached. Each line is generally provided with from 3 to 5 hooks, fastened to short snoods arranged one above the other about 18 inches apart. This style of gear is found about Kadiak, Alaska. Demijohns of various sizes, tied to the buoy lines by their handles, serve in place of keg buoys. The reason for using the former, as well as many other inconvenient devices, is their greater cheapness.

Mackerel.—While in San Diego several fishermen were consulted who

were more or less acquainted with the habits of the species of mackerel belonging to that part of the coast. According to their statements these fish strike the coast in the vicinity of San Diego in April and May, on their way north. They are invariably poor at that season, and, in fact, during most if not all of the year, although some claim to have seen a few fat mackerel in October. Their migratory habits are similar to those of the Atlantic mackerel. The fishermen assert that they have seldom seen them schooling at the surface, notwithstanding the many reports of steamers and other vessels respecting large schools of mackerel along the coast. It is probable that many of the schools of fish so reported are not mackerel, but herring, the appearance of these two species, when at a distance, being readily confounded by those who are not familiar with them.

It is very doubtful if mackerel approach this coast in sufficient numbers to warrant the fitting out of vessels for their capture, after the manner followed on the New England coast. Many persons have thought that it would be a paying investment to do so, in order to compete with the New England fishermen for the Pacific coast markets, supplying both the salt and fresh fish. Any such venture would be precarious, however, until the habits and abundance of the species have been positively determined, and certainly not more than two vessels should be fitted out in the beginning. All the evidence goes to prove, moreover, that the Pacific mackerel (*Scomber colias*) is greatly inferior in quality to its Atlantic relative (*Scomber scombrus*), and those eaten on the *Albatross* were pronounced insipid.

The fishermen of San Diego, Santa Barbara, and San Pedro resort almost wholly to trolling for the capture of mackerel. The practice of heaving to and raising them with troll bait seems to be unknown in this region. A few are caught in gill nets, but large quantities are never taken at a time by either method. The greater part of the catch is sold in San Francisco.

Barracuda and Bonito.—During the summer barracuda are abundant about San Diego and along the coast toward Santa Barbara, but after September they become scarce, although scattering individuals are taken the year round. Ten or 12 schooners and sloops, of from 10 to 28 tons each, belonging to San Diego, follow down the coast of Lower California a distance of about 170 miles in search of both barracuda and bonito. The latter species is also sometimes called Spanish mackerel. They are caught by trolling, and, after being split down the back like mackerel, are salted in bulk in the hold of the vessel, the same as codfish. The catch is chiefly landed in San Diego, where the fish are dried on flakes and then shipped to the Sandwich Islands and China by way of San Francisco.

San Pedro region.—The third trip out from San Diego began on the morning of February 4, and fishing with hand lines was commenced the next afternoon in San Pedro Channel. The first trial was made at

dredging station 2939, 27 fathoms, latitude 33° 36′ N., longitude 118° 09′ 30″ W.; the second in 26 fathoms, Fermin Point bearing NW. by W. (magnetic) and the south end of Catalina Island S. ⅝ W. (magnetic). In both of these localities the bottom consisted of sand and broken shells, and consequently no fish were taken on either trial.

A short distance from the latter position a few small boats were noticed, some at anchor, the others under easy sail. They were employed in fishing on South Bank, which extends SE. by E. (magnetic) from Fermin Light. This bank is 3½ miles wide and covers an area of about 30 square miles; the good fishing-spots are confined to a much smaller area, however, being generally in depths of 20 to 28 fathoms. About 25 small fishing boats are engaged in fishing on this bank the year round. Flounders, red rock-cod (called groupers locally), herring, bonito, mackerel, and smelt are caught in their proper seasons. Red rock-cod are taken during the entire year and are in greatest demand. Herring, mackerel, and smelt are caught in gill nets and drag seines, and frequent chiefly the shoaler water close to the shore. Mackerel are often trolled for as in the San Diego region.

Los Angeles is the principal market for all fish taken on this bank, a uniform price of 5 cents per pound being paid for all the species except mackerel. The price of the latter fluctuates according to the supply and demand; 200 pounds of fish is considered a fair day's work with hand lines.

The fishing for red rock-cod is carried on in a manner not unlike that for grouper in the Gulf of Mexico. When the ground is reached, the boat is luffed up into the wind and a sounding made with a baited hook attached to the lead. If no fish are found on two trials, the boat is again given headway, and a new berth taken a short distance from the first one. This operation is repeated until a place is found where the fish are abundant, when the jib is hauled down, the main boom guyed out, and the boat allowed to drift a short distance. If the fish continue to bite, the anchor is lowered. The fish feed upon small spots and ridges covered with kelp, and, as they can not be tolled away from their feeding ground, an anchorage has to be made as nearly as possible over these localities; otherwise very poor results may be expected. Fishing is actively continued until the place is exhausted, when a new berth must be sounded out. Frequently one or two boats will have excellent fishing while a dozen or more may meet with no success. These fish appear to move about from place to place, and the good fishing grounds of one day may be entirely deserted the next.

Most of the boats belonging to San Pedro that fish on South Bank and vicinity are sloop-rigged and keeled. They average 20 feet long and 6½ to 7 feet wide. Their accommodations are as good as could be expected on boats of their size, and are far better than on similar boats farther south. Herring and salt-water crayfish or rock-lobster (*Panulirus*) are used for bait.

The fishermen of San Pedro and adjacent places are mostly Scandinavians, Portuguese, and Italians, with the Scandinavians in the majority. Many of the Italians fish about San Clemente and Santa Catalina Islands, while those of other nationalities pay little attention to those islands, resorting chiefly to South Bank. The Italians have a few fish-houses and a flake-yard on Santa Catalina, where they dry fish in summer. No attempt is made to split and dry fish in the winter, and during that season the fishermen remain mostly on the inshore grounds. A favorite spot for summer fishing lies 1½ miles from the eastern end of Santa Catalina Island. Large quantities of red rock-cod are taken there, and also whitefish (*Caulolatilus princeps*) and fat-heads (*Trochocopus pulcher*) at certain seasons.

Hand-lines only are used for bottom fishing in this region. Trawl lines would be of little service on the rocky patches, as the fishing areas are of small extent and much of the trawl would be spread out over barren ground. The gear is rigged in the same manner as that of the hand-line fishermen of San Diego.

The San Pedro fishermen state that bonito strike this part of the coast the first of March and mackerel a month later. The method of catching them here, as previously explained, is by means of troll lines and gill nets. The fishermen also affirm that they have never seen mackerel schooling in the vicinity of South Bank, although herring and sea bass frequently school in large bodies. This is, however, the region from which most of the schools of mackerel have been reported by passing vessels. These reports are not unnatural in view of the fact that even an experienced eye is often deceived in attempting to distinguish between schools of mackerel and herring, and it is sometimes impossible to determine the species until specimens have actually been taken in the nets. Both mackerel and herring vary somewhat in their movements at different times. In the majority of cases, mackerel, when frightened, will "rush," as it is called, splashing the water with their tails in their haste to get away, but frequently they sink quietly below the surface. Herring, when schooling, on the contrary, often make a noise like falling rain upon the surface, which gives the fishermen a clew to the species, but this habit is far from universal. These deceptive appearances, misleading at times even to old fishermen, make it difficult to distinguish the composition of a school of fish from the deck of a rapidly passing vessel, and, until more authentic information is obtained, little credence can be given to the numerous reports concerning the abundance of mackerel off the southern part of California.

Santa Barbara Islands and Channel.—After leaving South Bank the ship was headed for Santa Barbara, where she arrived on the morning of February 6. At this place we took on board Mr. A. Larco, an experienced fisherman, as a guide to the region, and immediately proceeded to Santa Cruz Island. A short time was spent in trying to locate a shallow spot of fishing ground off the eastern end of the island near

San Pedro Point, but without success, probably on account of its small extent. Soon afterwards I accompanied Mr. Larco in the dingey for the purpose of testing the various grounds about Anacapa Passage and vicinity. Crayfish and fresh sardines were taken as bait. We commenced fishing in 30 fathoms, the SE. end of Anacapa Island bearing E. by N. ½ N., San Pedro Point NW. ¾ W. After remaining there about 15 minutes we shifted to the south and west into 27 fathoms, the above-mentioned points bearing E. by N. ¾ N. and NW. ½ W., respectively. In these two drifts of short duration, 20 red rock-cod and fatheads were captured.

Two other trials were subsequently made on the following bearings: In 28 fathoms, San Pedro Point, NW. by W. ½ W.; south and eastern end of Anacapa Island, E. by N. In 27 fathoms, the former point bearing NW., the latter ENE. The result of these trials was as follows: Twenty-two whitefish (*Caulolatilus princeps*), 4 fat-heads (*Trochocopus pulcher*), 26 red rock-cod, 8 black rockfish (*Sebastodes mystinus*). A short distance to the eastward of Anacapa Passage the bottom is sandy and comparatively barren.

Early in the evening an anchorage was made by the ship in Smuggler's Cove, where a large-mesh gill net was set for 2 hours among the rocks and kelp close by the shore. This was done about dark, a little too late to expect a large catch, such species as are generally taken in a gill net usually meshing just before dark or before sunrise. Only one crayfish was secured. The next morning the net was set in the same place and at the time several sea lions were observed upon the rocks, apparently watching our movements. The net was hauled after breakfast and contained 90 fish, of which the greater number were viviparous perch. The sea lions had been there before us, however, as was made manifest by the number of large holes in the net caused by their efforts to steal the fish. Sea lions are still found scattered about the Santa Barbara Islands, where they greatly annoy the fishermen, not only by devouring the fish taken but also by injuring and often entirely destroying their nets.

The remainder of the morning was spent in seining along the sandy beach of Smuggler's Cove, an excellent locality for that purpose, as there are no sharp rocks or other obstacles in the way. Notwithstanding its advantages, however, only a few perch, sharks, etc., were collected.

During the afternoon several hauls of the beam trawl were made off the southern side of Santa Cruz Island, one of which yielded several black-cod from a depth of 264 fathoms. These specimens were found to be nearly equal in flavor to those taken in more northern waters, and they were far superior to any fish which now find their way to the markets of Santa Barbara and Los Angeles. As the black-cod is an active fish, the capture of several in the slow-moving beam trawl would seem to indicate their abundance in this region in suitable depths, but further observations are necessary to prove the fact. This could probably

be done by making several trials with trawl lines. Many specimens of a species of flatfish (*Glyptocephalus zachirus*), sometimes called "sole," were collected with the black-cod. It is an excellent food-fish and would bring a high price in the southern markets; but, as it could only be taken in paying quantities by means of the beam trawl or some similar appliance, it will probably not become an article of trade for some time.

Anchoring over night in Becher's Bay, Santa Rosa Island, dredging was begun early in the morning of February 8. At station 2953, latitude 33° 47′ N., longitude 119° 58′ 15″ W., depth 82 fathoms, the dingey was lowered for the purpose of testing the bottom with hand lines. A short distance from the above station the bottom suddenly dropped off into 100 fathoms and a fair trial failed to give us any results. We shifted our berth several times in the direction of the shore, gradually shoaling the water to 60 fathoms, in which depth we obtained two red rock-cod. The position where we left the ship was about 10 miles from Santa Rosa Island. In changing berths we probably worked a mile in towards shore. Adding this to the distance steamed by the ship in going over this ground and we have a rocky ledge about 5 miles long and with a depth of 65 to 90 fathoms developed during the morning, on which red rock-cod, whitefish and fat-heads will probably be abundant at certain seasons. The extent of the ledge, however, may be much greater. The results of dredging indicate a rich bottom.

Late in the afternoon an anchorage was made on the south side of San Miguel Island, and just before sundown Captain Tanner and Mr. Larco rowed close inshore among the kelp and rocks, where, in a very short time, they caught 28 specimens of red rock-cod, whitefish, and rock bass. Nothing was taken over the ship's side, although repeated trials were made, the fish appearing to hover near the shore. During the summer crayfish (*Panulirus*) are numerous about the shores of San Miguel, where they are taken both for bait and for the market.

The next morning, getting under way at daylight, we steamed for Richardson Rock, which lies off the western end of San Miguel Island. A dense fog came rolling in from seaward, threatening to interfere with work, but it soon cleared away and we began a line of fishing stations from the rock to the northern side of the island by way of Wilson Rock. The first fishing was done in 44 fathoms, Richardson Rock bearing WSW. $\frac{1}{4}$ W. (magnetic), distant $1\frac{1}{2}$ miles. Ten red rock-cod and 10 yellow-tails were caught in a few minutes' time. The next berth was in 41 fathoms, Wilson Rock bearing E. by S. (magnetic) 2.3 miles distant, only one small flounder being taken during a 10-minute trial. The last trial made between Richardson and Wilson Rocks was in 36 fathoms, the latter rock bearing ESE. (magnetic), distant 1.6 miles; 4 red rock-cod and 3 rock bass were captured.

From the above station the ship ran E. $\frac{1}{2}$ S. 1.2 miles, and hove to in 42 fathoms, Wilson Rock bearing S. by E. $\frac{1}{4}$ E. and close to. Fifteen

lines were soon over the ship's side and fishing began. Mr. Larco and the writer went out in the dingey to try for fish around the rock. Seven or eight trials were made in depths varying from 25 to 35 fathoms, but we did not meet with as good success as was expected by Mr. Larco. He had frequently anchored over the same ground where we were fishing and had loaded his boat in a few hours, but this was late in the season. Many trials were also made to the southward of the rock, where large numbers of whitefish generally feed in summer, and still our efforts were only poorly rewarded. The total catch was 4 red rock-cod, 3 whitefish, 1 cultus-cod, 1 sculpin, 1 rock bass, 1 scorpion, and 1 black rock-cod. On returning to the ship we found the deck covered with fish. It had drifted but a few minutes when they were encountered in great abundance, every line hooking at once, and those who participated had keen enjoyment for 2 hours. Fishing began in 34 fathoms and was continued into 23 fathoms. The total number of fish taken was 555: 481 yellow-tail rockfish (*Sebastodes flavidus*), 49 red rock-cod, 1 cultus-cod, and other species.

Yellow-tail fishing very much resembles pollock fishing on the New England coast. The former species will invariably follow the lines to the surface, and frequently bites at the hook just before reaching the ship's side. Another peculiarity in which these fish resemble the pollock is that as soon as they begin to bite they swim up in the water, and more can be caught on short lines than on the bottom. After a few have been taken they will rise to within a few fathoms of the surface and dart in schools at the lines. They then immediately disappear, soon to repeat the same performance.

Dredging was carried on during the afternoon and several black-cod were taken in the beam trawl. In the evening the ship anchored off Santa Barbara.

February 11 was occupied in developing a small fishing bank which extends in an ESE. ¼ E. (magnetic) direction from Santa Barbara Light. The WNW. end of this bank is about 5 miles from the light-house. Its length is between 2½ and 3 miles and its width about 1½ miles. The depth ranges from 26 to 29 fathoms. and the bottom is chiefly sandy, with many rocky patches. This inshore bank was at one time a favorite fishing ground for the few fishermen of Santa Barbara. Fish were abundant and there was always a certainty of obtaining full fares; but, like most small banks upon which fishing is constantly prosecuted, it finally ceased to satisfy the demands, and for the past 7 or 8 years little or no attention has been paid to it. Since then the fishermen have resorted to the Santa Barbara Islands, which will, in all probability, meet their needs for many years. There is another small bank off Santa Barbara, the center of which lies about 3 miles E. ½ N. (magnetic) from the light. It is about a mile in length, NE. and SW., by one-half mile in width. The least depth upon it is 12 and the greatest 20 fathoms. It is covered with sandy and rocky spots, supporting a "live bottom."

On the morning of February 12 many hauls were made with the beam trawl in Anacapa Passage and off the southern end of Anacapa Island. A haul 11 miles south of the island in 603 fathoms (station 2980) was one of the richest made in this region. Two trials were also made for bottom fish on the southern side of Anacapa. The first was in 52 fathoms, 1¼ miles south of Arch rock; the second was in 36 fathoms, 1 mile north of the same rock. Six red rock-cod were captured. A strong breeze was blowing at the time, which caused the ship to drift rapidly, and consequently a large catch could not be expected, but a sufficient number were secured to demonstrate the presence of fish in this position, and they might have been taken in abundance under more favorable circumstances. Mr. Larco states, however, that, while they are numerous one day, the next day, and perhaps for a week following, not a bite may be obtained. These sudden changes may be due to the smaller fish on which they feed moving from spot to spot.

During the night the *Albatross* lay to off San Nicolas Island, and the next morning fishing was begun with hand lines. Two trials were made before good grounds were discovered. The third trial gave better results, as 17 red rock-cod, 3 whitefish, 2 yellow-tails, 1 fat-head, 1 cultus-cod, and 4 jacks (*Sebastodes paucispinis*) were landed in 10 minutes. This spot was 2 miles WSW. from San Nicolas Island; depth, 21 fathoms. We soon drifted, however, into depths where no fish could be obtained. Returning to the first position in 22½ fathoms, the biting began at once, and we secured 4 red rock-cod, 1 yellow-tail, 1 white fish, 3 fat-heads, and 1 cultus-cod.

An anchorage was made in the afternoon on the northern and eastern side of Santa Bárbara Island, where the naturalists were landed. A crab net, baited with fresh whitefish, was put over the side, but nothing was captured in it. The hand lines did better, although during the first hour no bites were felt. Towards evening, however, a school of red rock-cod and whitefish passed under the ship, and between 40 and 50 of them were caught. The longer we fished the more plentiful they seemed to become. The dingey, with Captain Tanner and the writer, was rowed to a point about half a mile to the westward of a reef of sharp rocks which makes off from the shore, where we fished for about an hour, making several changes in our position during that time. The catch consisted of 3 red rock-cod and 1 fat-head. One large flounder (*Paralichthys californicus*), of the kind called halibut by the fishermen of San Diego, was hauled to the surface of the water, but owing to its being "lip-hooked" it managed to free itself, greatly to our disappointment.

The following morning, after running a line of soundings to Santa Catalina Islands, the ship was headed for San Diego, where we arrived at 6:20 p. m.

General remarks on the fish and fisheries about the Santa Barbara Islands and Channel.—Mackerel strike in at the Santa Barbara Islands and Channel about the first of March and remain until October. Mr.

Larco has never seen any fat mackerel on the coast and doubts if they ever become fat. They sometimes school in small "pods" during the summer months in Santa Barbara Channel, but he has never seen them school in the vicinity of San Pedro or farther south. They are caught by trolling and in gill nets, but chiefly by the former method.

The herring accompany the mackerel, but remain much longer in this region. Strong westerly winds drive them offshore, where they remain until the wind changes. They are taken in gill nets and drag seines.

Sardines (*Clupea sagax*) are found here the year round in considerable numbers, and are captured in gill nets and drag seines, chiefly for bait. They are affected by westerly winds in the same manner as the herring.

Bottom fish bite best in the morning and on slack tide. Fat-heads, yellow-tails, red rock-cod, black rockfish, and whitefish are similar in their habits to the shore cod and pollock of the Atlantic coast.

Rock-lobsters or crayfish, sardines, and herring make the best bait, although whitefish and perch are very good. Squid are sometimes caught in great numbers in nets and drag seines, but, strange to say, it is stated that the fish will not bite at them, and they are not considered worth the trouble of attaching them to the hooks.

Sea bass, of which no specimens were taken by the *Albatross*, are said by Mr. Larco to be first seen sometime in March. After remaining upon the coast about two months they suddenly leave, reappearing in July and August. They have been known to strike the coast three times during a season, but as a rule they appear only twice. The customary method of fishing for them is with gill nets. The net is 40 fathoms long and 3 fathoms deep, with a 6-inch mesh. A southeast wind causes them to seek deeper water, and very few are taken at such times.

Sharks and dogfish give the fishermen much trouble in the summer, when they are very abundant, playing sad havoc with the nets and all other kinds of fishing appliances. There are many excellent places on the Santa Barbara Islands where try works could be built at slight expense in localities where these species might be captured in large numbers within half a mile of the shore.

During January, February, and March only hand-line fishing is resorted to. Through the four succeeding months no attempt is made to catch any fish but barracuda and mackerel. During the last months of summer but little attention is given to fishing of any kind, there being little demand for this kind of food. The poor demand for fish at that season arises from the fact that the fishermen have not the means of preserving and marketing their catch in suitable condition. The price of ice is so high that its use would increase the cost of fish beyond the means of the majority of the people. Most of the fish are now sold at from 10 to 15 cents per pound in the Santa Barbara market, but 18 cents is sometimes paid for fat-heads, whitefish, red rock-cod, and yellow-tails.

Nearly every spot about the Santa Barbara Islands where rocky

bottom is found may be considered a fishing ground. Red rock-cod and fat-heads are found from close to the rocks out into depths of 90 fathoms, but they are most abundant where the water is from 15 to 25 fathoms deep. Some places are much more favorably regarded than others. Anacapa Passage is one of the best grounds, and can generally be relied on throughout the entire year. In the vicinity of Richardson Rock is another good ground, and Wilson Rock is considered the most prolific spot about the islands during the first three months of the year. Between these rocks and the northern end of San Miguel Island red rock-cod, fat-heads, and whitefish occur in considerable numbers in the summer, but during winter these species are more abundant about the rocky patches off the shores of Santa Rosa, Santa Cruz, and Anacapa. The best ground for yellow-tails is in close proximity to Wilson Rock.

The best season for fishing is during the winter months, when the winds are variable and gentle. In summer the northwest trades sweep down the coast, often with great velocity. At such times the fishermen resort to the northern end of the group, thereby receiving the benefit of a fair wind to Santa Barbara when a full load has been secured.

Rainy weather affects the movements of both surface and bottom fish. Mr. Larco states that he seldom finds anything in his nets during a rainy spell, and long experience has taught him to resort to some other method of fishing during such times.

The salt-water crayfish (*Panulirus interruptus*) is caught in trammel nets and in small net traps. The latter are very much like the traps used by the boat fishermen along the shores of Long Island Sound and Massachusetts Bay for catching cunners. They are somewhat smaller, however, and have two iron hoops instead of one, to which the net is fastened. One is at the top and measures about 2 feet in diameter; while the second, at the bottom, is only 10 inches across. They are placed 2½ feet apart, that being the length of the trap. A wire cage about the size of a saucer is attached at the bottom and serves to hold the bait. The bridle, to which the line for lowering and hauling the trap is fastened, consists of four lines tied to the upper hoop. These lines are rove through a small piece of wood which acts as a float to prevent their settling down over the cage and covering the bait. When resting on the bottom the top hoop falls in such a manner as to fully disclose the bait.

Mr. Larco's boats are all carvel-built and with keels; they are open and have a wash rail, small deck forward, and lateen rig. They are about 25 feet long, 7 feet wide, have a straight stem and sharp stern, with the rudder hung outside. The accommodations for sleeping and cooking, as in all other boats of this class, are very poor. The fish are thrown into the bottom of the boat as soon as caught, and covered with sea-weed to protect them from the sun.

THE REVILLA GIGEDO ISLANDS, LOWER CALIFORNIA, AND THE GULF OF CALIFORNIA.

San Diego to the Revilla Gigedo Islands.—Having made the necessary preparations, the ship left San Diego, February 26, for a cruise to the southward, including a visit to the Gulf of California. Soundings were carried to Guadeloupe Island, where we lay to during the night of the 27th. The following morning, while a party landed on the island, Professor Gilbert and the writer went in a small boat to look for fishes near the shore. We were well provided with lines and bait, and also had five torpedoes with a Farmer electric machine for exploding them. The torpedoes were used in depths of 4 to 6½ fathoms close by the shore, where the bottom was plainly visible, but we did not succeed in killing any fishes by this means, and only a few specimens were seen among the rocks. Hand lines were tried with poor success. Several "Garabaldi" (*Pomacentrus rubicundus*) were observed swimming gracefully about, their red color contrasting strongly with the black bottom. A small school of smelts was tolled around, and two were caught, the sole result of our day's work. Hand lines were also used from the ship, while dredging in depths of 19 to 26 fathoms, but without success.

Alijos Rocks, in latitude 24° 58′ N., longitude 115° 52′ 36″ W., were reached on the morning of March 2. They consist of three large rocks cropping out from the sea, and at a distance appear like three square-rigged ships sailing before the wind. A short trial with hand lines in 34 fathoms on the northeast side of the rocks and close to them gave no results. A few starfish were brought up by the tangles, but the beam-trawl net was badly torn on the rough bottom. Sea-elephants have been reported from time to time about the Alijos Rocks, but none were seen by the *Albatross*, and it seems impossible for them to exist there, as the sides of the rocks are nearly perpendicular from base to summit and between the rocks is a solid wall of breakers even with a comparatively smooth sea. The reports were undoubtedly erroneous.

The following morning at 10 o'clock Clarion Island was sighted. Several soundings were made during the day, and at 4 p. m. the ship anchored in Sulphur Bay in 10 fathoms of water. Just before dark a menhaden net was set in 4 fathoms a short distance from the shore. A number of sharks were observed swimming about, and it was thought best not to allow the net to remain out too long for fear of its being torn to pieces. We therefore started out to haul it at 9:30 p. m. The water was phosphorescent, and on arriving at the spot we were met by numerous sharks patrolling up and down each side of the net. The latter was empty, but there were unmistakable indications that some fish had meshed in it, as the net contained several large holes near the middle, evidently made by sharks in seizing their prey.

Early the next morning I accompanied Professor Gilbert in one of the small boats to do some fishing in shallow water. We anchored in

about 3 fathoms a short distance off a high volcanic promontory on the eastern side of the bay. The water was perfectly clear and presented a beautiful sight. Volcanic rocks and corals composed the bottom, which was cut with winding caverns running in all directions and sheltering many fishes of brilliant colors. No sooner was a line thrown into the water than hundreds of fishes would dart toward the bait. Only a few of the species would take the hook, and great care had to be exercised in pulling them up to prevent their escaping with both hook and sinker. They were very active, and several times succeeded in parting the lines. We had been fishing only a short time when many sharks appeared about us and did much damage to our gear. Returning to the ship we found the crew had taken several hundred fish, including a number of large sharks; Captain Tanner, who had been fishing in a small boat in another part of the bay, was also very successful. After lunch the fishing was continued and many additional species captured.

On the morning of the 4th a landing was made on the beach and, although the shore was very rough from coral growth, several successful hauls were made with the small seine. Two large specimens of eels were collected in the tide pools, and the seine was also used in a fresh-water lagoon, a short distance back from the beach. There are two of these lagoons on the island, which appear to serve as watering-places for the birds of the region. After returning to the ship late in the afternoon, she steamed around the western end of the island and along the northern shore to ascertain if there were any sea lions or sea elephants about, but none were observed. A course was then laid for Socorro Island, which was reached at midnight the next day, and the following morning an anchorage was made in Braithwaite Bay on its southern side. Fishing and other collecting were carried on unremittingly throughout the day. The same fishes were found as at Clarion Island and several additional species were collected; their surroundings were also the same, and through the clear water we could plainly see their bright and many-colored iridescent forms, combining to produce a brilliant scene such as can be observed only within the tropics. Anchoring near the rocks, we made use of a water glass in connection with our hand-line fishing. A few species would not take the hook and the bait was frequently stolen by other forms. While the mouths of many kinds were so small that they could be caught upon a small hook only, a large wire hook would have been required to hold them, and but few of these were brought to the surface. The next morning a crab net was included in our outfit and by its use we managed to entrap many of the coveted species. Sharks were exceedingly abundant and troublesome, and the utmost care had to be exercised to prevent their carrying away our gear.

Each evening the electric light was used at the surface, tolling many fishes around the ship. About two-thirds of a barrel of small fry were captured, and also 8 chub mackerel. I split and gibbed a few of the

latter, and found their ovaries about as far advanced as are those of the common Atlantic mackerel in the latter part of March and the first of April. Sixty species of fish were secured at Socorro and Clarion Islands, and of these Professor Gilbert considered that about one-fifth were edible. Those eaten upon the *Albatross* were pronounced superior to any taken off the Santa Barbara Island and on Cortez Bank. The region is too far distant for California fishermen, however, although it might hold out inducements to the Mexican, but the grounds are small and only a few vessels could fish at a time. Whales were abundant around both islands, and a few porpoises were seen.

March 10 we reached San Benedicto Island and two collecting parties were sent off from the ship. Fishing was practically a failure, however, owing to the abundance of sharks and horse-mackerel, and nothing new was obtained. This island, like the other two of the group, is of volcanic origin. Close to our anchorage was an extinct volcano, of which half of the crater had been broken away, leaving the interior exposed to view. The top of San Benedicto is covered with high, coarse grass, but no cactus was found on the part examined. Sea birds and whales were numerous.

San Benedicto to La Paz.—The ship left San Benedicto on the afternoon of the 10th, and on the morning of the 12th she arrived at Pichilinque Bay, where a supply of coal was to be obtained. We fished with hand lines, seines, and gill nets in the different parts of the bay, but without much success. A menhaden gill net, set close to the ship's anchorage in the evening and hauled in the morning, was badly torn by sharks. But little fishing is carried on at La Paz. There are three or four Italians who occasionally visit the islands in the bay for that purpose, and bring a few fish to market. Their trips are made with no regularity, but only when they have need of a little money. They use dugout canoes, and the fish that are not disposed of fresh are split and salted, and afterwards exposed for sale in a very uninviting condition. The markets are very simply arranged. A common table set on the side of the street and covered with half a dozen dirty and bad-smelling fish compose the fish dealer's stock in trade. All the fish, both large and small, are split down the back, and the heads are left on. In the case of the salted ones the flesh is gashed crosswise in order that it may absorb the salt quickly, which is essential to its preservation. Several years ago a French fisherman supplied the town with fish, but he has since gone to Guaymas.

La Paz to Conception Bay and Guaymas.—Having finished coaling ship, we left La Paz on the morning of March 16 and proceeded northward on the peninsular side of the Gulf of California. Before anchoring for the night off the western side of San Josef Island four hauls were made with the seine on the adjacent shores and a few fish were captured. Pearl oysters and other interesting shells were dredged by the steamer close by. The next morning the seine was hauled several

times in a salt-water lagoon on the western side of the island, securing about a barrel of anchovies and some other species. A large fish was also attracted by the fish thrown back in the water, but it evaded all attempts at capture. About 25 miles south of Carmen Island we sighted a school of fish which had the appearance of mackerel, but they were too far distant to determine their character. A little after dark we anchored off the southern side of Carmen Island. The electric light was displayed at the surface and light fishing lines were thrown over. A number of chub mackerel and other species were caught by this means, the largest of the mackerel measuring 13¾ inches in length. The most of them were split and gibbed, and it was discovered that nearly all were males. The milt was about as far developed as in the specimens taken at Socorro Island. The spawning season probably occurs sometime during the latter part of the spring or the first part of summer. A portion of the following day was occupied in hauling the seine on a beautiful beach in Salinas Bay where we were at anchor, and many kinds of fish were taken. Hand-line fishing proved a failure.

Our next stopping-place was Conception Bay where hand-line fishing and seining were carried on during the morning. Only two sharks were captured with the hand lines, but several interesting species were collected with the seine on a coral and shelly beach at the northern side and near the entrance of the bay. In the afternoon we anchored off the mouth of Mulege River, and two seining parties were kept at work on the shore during the remainder of the day. Mullet and red snappers were taken in considerable numbers. Three miles up the river there is a mining town with about 4,000 inhabitants. Two small schooners and a sloop were anchored at the mouth of the river. They make regular trips to La Paz and Guaymas. The largest schooner was of 33 tons register; she was built in San Francisco at a cost of $4,500. She was of fair model and neatly rigged, being the best fitted and rigged schooner I had yet seen on the Pacific coast, but like most of the schooners on this coast she carried no gaff to her mainsail. Her beam was 18 feet, depth 5½ feet, draft 6½ feet. The other two vessels were of Mexican build. March 20 we arrived off Guaymas Harbor, and the next morning steamed up to the city.

Guaymas.—The fish market at Guaymas is but little superior to that at La Paz. The French fisherman formerly resident at La Paz and several Italians supply the town with fish. Three-fourths of a cent per pound was the standing price for all kinds of fish during our stay at the place. Shipments are sometimes made to the interior of the State and frequently to the southern part of Arizona. Generally 3 and 4 cents a pound are realized from such shipments.

All fish taken during the winter months are caught with hook and line, but in summer seines only are used. This change is made to avoid the destruction of the gear by sharks. Many sea bass (*Cynoscion macdonaldi*) are obtained with lines; they are of large size, sometimes reach-

ing 150 pounds. Although tough and thick-skinned, they are split and cured in the manner of the other species described above. The fishing boats, of which there are half a dozen in all, do not differ materially in their rig from those used by the fishermen of San Pedro, California.

Guaymas to the head of the Gulf and return.—Leaving Guaymas on the morning of March 23, we proceeded up the coast on the east side of the Gulf, past Tiburon Island and Angel de la Guardia Island, doing some dredging on the way. In the evening of the 24th we anchored in 13 fathoms off George's Island. The next morning we did some collecting upon the island and also tried the hand lines from the dingey a short distance from the rocks. Fish were scarce, and although we shifted our position several times, only two groupers and two trigger-fish were caught during an hour's time. The scarcity of fish was undoubtedly due to the abundance of sea lions about the island, which set up a fierce howling as we approached the rocks, scampering from their resting places and jumping or tumbling into the sea. Later in the afternoon we anchored in Adair Bay, and the different kinds of collecting were engaged in. Hand-line fishing proved more successful than seining. Several large sea bass and another large fish were caught from the ship. A turtle was also captured with a trolling line while rowing to shore.

A night anchorage was made about 5 miles south of Shoal Point at 9:30 p. m. Hand lines were put over, and in a few minutes they were cutting and sheering through the water in a most lively manner. It was a hard job hauling the fish to the surface and a far more difficult one pulling them over the rail. Finally, however, three large bass were landed on the deck, weighing 79, 82, and 140 pounds each. Sea bass are abundant along the eastern shore of the Gulf and good fares could be obtained if there were a market for them. Our next fishing station was at Shoal Point, where two seines were kept in operation on the sandy beach during the forenoon with good results. One Spanish mackerel was taken. Returning on board, the ship worked northward, finally anchoring at the mouth of the Colorado River, Direction Hill bearing NW. $\frac{3}{4}$ N. At 9 p. m. Professor Gilbert and the writer with two seamen set a shad gill net, but only a few sharks were obtained. The next morning the ship crossed the head of the Gulf, touching at Consag Rock on the way. The bottom was tested with hand lines in several places among the rocks, but as in all other localities where sea lions occur the fishing was exceedingly poor. From Consag Rock the beam trawl was used every 15 miles, but the material was not so rich as on the eastern side of the Gulf. Fishing was carried on in San Luis Gonzales Bay, and on the afternoon of March 30, we again arrived at Guaymas.

The following day we proceeded southward, fishing and collecting in the lagoons and along the beaches as far as the Yaqui River. Oysters were abundant in several places; they were of excellent quality and compared favorably with those of Chesapeake Bay. The Yaqui River

Indians monopolize the oyster business, supplying the inhabitants of Guaymas and of the neighboring region. An oyster cannery was established at Guaymas several years ago, but the enterprise did not turn out successfully. On one of the beaches in the vicinity of the Yaqui River we obtained mullet, red snapper, alewives, and flounders in considerable numbers, and also captured one Spanish mackerel.

We crossed the Gulf April 2, and reached La Paz early the next morning. The ship then ran down to Pichilinque Bay for the purpose of coaling. The pearl fishery is the principal industry of La Paz, giving employment to 500 men. About $100,000 worth of pearls are secured yearly in this vicinity; the bulk of these are shipped to Germany. Leaving Pichilinque Bay on the 6th we sailed down the coast and anchored at noon the next day off Cape San Lucas, where part of the afternoon was given to seining and hand-line fishing.

Cape San Lucas to San Francisco.—Steaming northward along the outer coast of the peninsula, we made our first stop at Magdalena Bay, anchoring in Man-of-war Cove. Seines were used on all suitable beaches within 4 or 5 miles of our anchorage, and also near the mouth of the bay close to Belcher Point. Food-fishes were plentiful in both localities, and among the specimens taken were mullet, perch, anchovies, smelts, and flounders. When off the entrance to the bay, about a mile northward of Entrada Point, we ran past several schools of fish. A pelican dived into one of them, whereupon there was the unmistakable "rush" of mackerel. This was the first school of that species which had given us positive proof of their identity by their movements. These bodies were working northward, but as it was nearly dark when we came upon them, we were unable to continue the observations. At Port San Bartolome both seines and hand lines were tried. Nothing was taken on the latter, which were used in several places among the submerged rocks and ledges off the mouth of the harbor, the bottom seeming to be destitute of life. Mullet, smelts, anchovies, and flounders were plentiful on the beaches. The U. S. S. *Ranger* arrived at this point at the same time as the *Albatross*, and with her large seine 167 turtles were captured in a single haul. As turtles are scarce on the western coast of the United States, it might pay a vessel to visit this region once or twice a year for the purpose of obtaining supplies for the California markets. A concession would be necessary from the Mexican Government, but it could be obtained without difficulty.

Stops were subsequently made at San Quentin Bay, Cerros and San Martin Islands, and on April 14 the *Albatross* reached San Diego. By direction of the Commissioner of Fisheries, Professor Gilbert and the writer were temporarily detached from the ship at this port, in order to make an investigation of the Lower Colorado and Gila Rivers with reference to the shad planted in them several years before. In the meantime the *Albatross* proceeded to San Francisco, where we joined her May 21, just as she was starting northward on her summer cruise.

COASTS OF WASHINGTON AND OREGON.

San Francisco to Departure Bay and Frazer River.—Leaving San Francisco on the same day, we proceeded directly to Departure Bay, Vancouver Island, for the purpose of coaling, arriving there May 25. During the stay in port I was occupied in obtaining additional information respecting the fisheries of the region.* A visit was paid to Mr. Vozza, an Italian fisherman, who conducts a small fishing business on one of the islands in the bay. He said that the past winter had been exceptionally mild and consequently the fishing for dogfish much poorer than usual. These fish would visit the bay in large numbers during cold spells, but every time the weather moderated they immediately sought deeper water. It is not probable that the temperature had a direct effect upon the dogfish, but it influenced the presence of the herring on which they feed. The herring usually resort to Departure Bay during the winter in incredible numbers, and the dogfish follow them about from place to place. Several thousand herring were smoked by Mr. Vozza during the preceding winter, but he found no demand for them in Nanaimo or elsewhere. Three thousand gallons of dogfish oil were put up between December 1 and the last of March by two men. The usual yield for the same time is about 5,000 gallons.

Mr. Vozza says that the spring run of salmon strikes that river in March and remains there until the latter part of June. In July the suk-kegh salmon enter the river and continue in it until sometime in August, after which the spring salmon return and are plentiful for three or four weeks. A form called "cohoes" by the natives predominates during September, and in October there are several species running.

There are now fifteen canneries on the river, three having been built during the present season. The sizes of mesh in the salmon nets are 6, 7¾, and 8 inches. The 6-inch mesh is used for the suk-kegh salmon. About 2,000 men are engaged in the fishery this year.

Halibut fishing, Washington to Sitka, Alaska.—From Departure Bay we proceeded to Seattle, Washington. In this city Messrs. Louch and Johnson started a wholesale and retail fish establishment in the fall of 1888, investing $20,000 in buildings and equipment. The yacht *C. H. White*, of San Francisco, was chartered by them, and has made three trips to Cape Flattery Bank, taking in all 100,000 pounds of halibut. About 60,000 pounds were shipped fresh to New York, but transportation rates were so high that nothing was realized from the venture. The remainder were smoked and put up in boxes of 30 pounds each. Mr. John Crosgrove, of Gloucester, Mass., superintended the shipping and smoking of these fish. Hickory and alder wood and corn cobs were employed as fuel for the smoking, and the prepared fish were equal in appearance and flavor to those treated in the same manner in Gloucester. There is said, however, to be one defect in the halibut taken on this coast for the

* For the account of a former visit see U. S. F. C. Bulletin for 1888, pages 51, 52.

purposes of drying and smoking, and that is that they have numerous white "gelatinous" streaks through the flesh. This is considered to impair their value for preparation in these ways. The same peculiarity was noticed in the fletched halibut taken off Queen Charlotte Islands by Capt. S. Jacobs, in 1888, and shipped to Gloucester.

The schooner *Rose Oleson*, of Astoria, chartered by parties in Port Townsend has made one trip to Cape Scott this season for halibut. She sailed the first part of April and was gone five weeks, bringing back 15,000 pounds, of which 1,800 pounds were smoked and the remainder sold fresh.

January 3, 1889, the schooner *Oscar and Hattie*, Captain Silas Calder, sailed from Port Townsend for Alaska on a fletched-halibut trip. She proceeded directly to Sitka, and began fishing on the inshore grounds adjacent to Baranoff Island, where halibut had been reported to be most abundant. Work was carried on continuously whenever the weather permitted until March 1, but halibut were very scarce, and not enough were caught to keep the lines baited. Captain Calder stated that while there may be enough fish on these grounds to furnish fishing for a few Indians in their small canoes, a large vessel could not expect to meet expenses here. Subsequently he changed his position to the deeper waters offshore, but met with no better success. He also thinks it would not pay to follow the halibut to the inclosed waters among the islands of the archipelago during the summer months for vessel fishing, as the fish are not known to resort very abundantly to any one place. During his stay off Sitka, he encountered many heavy gales, doing much damage to the rigging and fishing gear, but they had no snow or ice to contend against as would have been the case in the same latitude on the north Atlantic coast.

In the early part of March, having met with no success off Sitka, he proceeded southward and fished in the neighborhood of the Queen Charlotte Islands, Cape Scott, and Hecate Channel. Halibut were more common in these localities but not abundant. They seemed to be easily caught up, and frequently he was obliged to shift his position twice a day. Fishing was continued until the first week in June, and by dint of hard and persevering work he managed to obtain a fare of 140,000 pounds. The halibut were much larger this year than last. Captain Calder estimated the average weight of those taken by him at about 65 pounds each. None could be caught in water over 45 fathoms deep.

In my last report* I stated that it would be possible for vessels on the northwest coast to obtain two fares of fletched halibut a year, and to that extent these vessels would have an advantage over those of the Atlantic. This statement may require modification, in view of Captain Calder's experience of the past season, but until the grounds have been more fully investigated, and their position, extent and

* Bulletin U. S. Fish Commission for 1888, page 64.

resources more satisfactorily determined, it will not be safe to predict the future of this fishery. The outlook for the fresh-halibut fishery is also not promising for the immediate future, chiefly on account of the lack of markets. The local markets are not sufficiently large to take the catch of more than one vessel, and the expense of shipping halibut to Eastern cities is so high as to preclude any profit to the fishermen. The cost of ice has been greatly reduced during the year, however, and artificial ice can now be purchased in Port Townsend at $8 per ton.

Bank off Gray's Harbor, Washington.—Leaving Seattle June 6, we passed out by Cape Flattery and began fishing the next morning on the bank off Gray's Harbor. A trawl line was set at dredging station 3048 (latitude 46° 45′ 30″ N., longitude 124° 33′ W.), 52 fathoms, extending in a southwesterly direction into 60 fathoms. We lay to in the dingey at the leeward end and put over hand lines, but found that the tide was running too strongly toward the southeast to do anything at that kind of fishing. The day was fine, with a gentle breeze from the WNW., accompanied by a moderate swell. After about 2 hours the trawl was hauled and yielded us 4 dogfish (*Squalus acanthias*), 2 skates, 4 orange rock-cod, and several starfish. The ground line and ganging of the trawl indicated that there were many slimy depressions on the bottom. A few red rock-cod were taken with hand lines from the ship, and also 1 ratfish (*Chimæra*).

Heceta Bank, Oregon.—In the afternoon there was a stiff breeze from the northwest, which assisted us on our course toward Heceta Bank, where we arrived the next morning. The trawl line, baited with fresh red rock-cod and salt herring, was set for over 2 hours, at dredging station 3050 (latitude 43° 01′ 15″ N., longitude 124° 57′ W.), 46 fathoms, bottom very rocky. There was a strong tide running to the southeast at the time, and as far as the eye could see the surface was covered with Portuguese men-of-war sailing before the gentle breeze. The trawl line yielded 11 red rock-cod, 1 orange rock-cod, 1 sea trout, and 1 ratfish; the hand lines used from the ship gave 26 red rock-cod, 2 orange rock-cod, 4 yellow-tails, and 1 cultus-cod. Hand lines, therefore, seemed better adapted to the locality than trawl lines.

At 2:30 p. m. the same day three small boats were dropped at hydrographic station 1839 (latitude 44° 59′ 30″ N., longitude 124° 50′ 30″ W.), 43 fathoms, for the purpose of testing the bottom on Heceta Bank in several places at the same time, and with the special view of determining the presence of halibut, if possible. The boats anchored within half a mile of each other and fished only with hand lines. The trial lasted an hour, several lines being also used from the ship at the same time. Twenty-two red rock-cod, weighing 192 pounds, were caught by the small boats, and 12 of the same species from the ship. As only three lines were put over from the ship, it may be considered that they had the greater success. In each trial made on the bank the ship seemed to meet with better results while drifting than did the small

boats at anchor, the fish apparently congregating on detached rocky spots or ledges. Good fishing would continue for a time and then suddenly cease, making it necessary to seek a new place. The last fishing for the day was done at dredging station 3054 (latitude 44° 13′ N., longitude 124° 44′ 30″ W.), 53 fathoms, beginning just before sundown. Eleven lines were put over, but we captured only 1 yellow-tail. It has been our experience that red rock-cod do not as a rule bite well in the evening.

The tangles were used many times during the day, the bottom being too rough in most places for the beam-trawl. The fauna is as rich as on Flattery Bank at the mouth of the Straits of Fuca, affording good feeding grounds for fish. The scarcity of halibut at this place can not therefore be due to the quality of the bottom, and we were greatly disappointed in obtaining no trace of them. A single specimen, weighing 10½ pounds, was taken by the *Albatross* in October, 1888, a season of the year when they might be the least expected, and it was thought that they would prove to be more abundant earlier in the year while they are most plentiful on the Flattery grounds. Our investigations tended to disprove the supposition, for had they been at all common it is more than likely we should have succeeded in capturing some of them during our many trials. This was the season of their greatest abundance on Flattery Bank, but it is possible, though not probable, that the season is different in the two regions. Mr. William T. Radir, of Yaquina Bay, Oregon, has recently constructed a steam schooner furnished with all the modern fishing appliances, with which he intends to make a thorough trial for halibut on Heceta Bank. His plans are not based upon the *Albatross* reports, but this bank has long been regarded by Oregon people as holding out special inducements for salt-water fishing, the value of which has never been determined.

Off Yaquina Bay, Oregon.—The next morning hand-line fishing was begun from the dingey about 7 o'clock at dredging station 3055 (latitude 44° 41′ 30″ N., longitude 124° 09′ 15″ W.), 28 fathoms. This was in the vicinity of Yaquina Bay, Oregon. The wind was blowing fresh from the northwest, producing a choppy sea which caused the boat to pitch about considerably. The bottom was sandy and the results were negative. In the mean time, however, the beam trawl had been used from the ship, capturing a large quantity of flounders and several other species, seven in all. The bottom was again tested with hand lines a short distance from the last position, at dredging station 3057 (latitude 44° 43′ 41″ N., longitude 124° 15′ 45′ W.), 43 fathoms. It had been reported that this was one of the localities where the true cod abounded, but we found there only the so-called red rock-cod, specimens weighing 7 and 8 pounds being fairly abundant. The inhabitants of this part of the coast are not familiar with the cod (*Gadus morrhua*), and readily mistake for it the many species of red rock-cod. common

on the coasts of Oregon and Washington. The *Albatross* has thus far found no trace of the *Gadus morrhua* on the Oregon coast.

Soon after the last trial we ran under the lee of Yaquina Light and came to anchor, making a series of trials with hand lines along the rocky shore, but we obtained no fish.

At 3 p. m. we got under way and proceeded 8 miles to the northward, heaving to in 38 fathoms of water, dredging station 3058 (latitude 44° 48′ N., longitude 124° 10′ W.). No bites were felt during the drift, although a fair trial was made. Many flounders, 1 herring, and several small specimens of *Octopus* were subsequently taken in the beam trawl, some 7 or 8 miles farther offshore.

Astoria, Oregon.—Returning northward, we reached the mouth of Columbia River June 10, anchoring at 3 p. m. off Astoria. Salmon have been exceptionally scarce in the Columbia River this season, the largest catch made by one man in a day having been 37. There is considerable talk among the cannery owners of abandoning gill-net fishing next season and resorting to traps. Many shad have been taken in the gill nets this season. They were mostly shipped to Portland.

Tillamook Rock Grounds.—June 14 we proceeded to Tillamook Rock, south of the Columbia River, and set cod and halibut trawls. Acting upon information obtained from the captain of the Light-House steamer *Manzanita*, the outer trawl buoy was thrown over close to Tillamook Rock, and the inner one near the main shore, thereby covering the entire ground from which halibut have been reported. Hauling the trawl at the end of 2 hours, we secured one halibut weighing 25 pounds, one skate, one red rock-cod, and hundreds of starfishes. During the same time three halibut and two ground sharks were taken on hand lines from the *Manzanita*. Hand-line fishing would be the most profitable here at this season. The starfishes were a great source of annoyance and gave as much trouble as the dogfish on other grounds. Nearly every hook on our trawl had been seized by a starfish, and some had two clinging to them. On the south side of the rock, flounders, tomcod, and crabs were obtained in the beam trawl, but nothing was caught on the hand lines, although they were tried at every station. The grounds about Tillamook Rock cover a very small area suitable for boat fishing, but they can never become the resort of large bodies of fish, and offer no inducements to vessel fishermen. Scattering halibut may be found here during a large part of the year.

From Tillamook Rock we ran 3 miles offshore, SW. by W. ½ W. (magnetic), and fished with hand lines in 46 fathoms, capturing one red rock-cod. A second trial was made in 42 fathoms, the rock bearing NE. ½ E. (magnetic) 2.6 miles, with no results, very little material also being taken in the beam trawl at the same place. No better success was had in 27 fathoms off the mouth of the Columbia River, Cape Disappointment bearing NE. ½ E. (magnetic) 6.8 miles; nor again 15 miles

from this position in a NW. by W. $\frac{1}{4}$ W. direction, although flounders and skates were taken in the beam trawl.

Flattery Bank, Washington.—Leaving the Oregon coast we proceeded to the halibut bank off Cape Flattery, arriving there June 14. The cod and halibut trawl was immediately set in 31 fathoms, very rocky bottom, Cape Flattery bearing E. by S. $\frac{1}{2}$ S., and Cape Beall NW. by W. The tide was running ebb, but not strong, and a dense fog prevailed. At the end of 2 hours the following fish were taken from the hooks: 8 halibut, 10 red rock-cod, 1 sea trout, 1 cultus-cod, 1 skate, and 45 dogfish. The halibut averaged 35 pounds each in weight, and the red rock-cod 10 pounds. The cultus-cod weighed 19 pounds. The bottom was so rough that many of the hooks caught upon it while hauling, and when within about 10 fathoms of the outer end the ground line parted, having come in contact with a sharp or ragged edge of rock. No gear was lost, however, as we soon picked up the outer buoy and hauled from it. While tending the trawl one small halibut and about a dozen dogfish were caught on hand lines from the small boats. We arrived on board the *Albatross* about 2:05 p. m., and found that they had taken one halibut from the ship, the largest captured during the day. It weighed 93 pounds, and increased the average weight of our entire catch of halibut to 42 pounds each.

A native canoe containing four Indians came alongside about the time we had finished hauling the trawl. They had been fishing with hand lines, using the primitive wooden hook, with which they had captured 15 small halibut.

After completing the investigations on Flattery Bank we steamed to Neeah Bay, arriving there about 3 p. m. the same day, and June 15 we proceeded to Seattle. The Indians of Neeah Bay visit Flattery Bank daily during the halibut season, whenever the weather permits, and bring in considerable quantities of halibut, cultus-cod, and red rock-cod. Herring, smelt, and squid are used as bait, in their respective seasons, and halibut and red rock-cod are also used for the same purpose.

In the fall of 1888, several fishermen, well equipped with dories, trawls, etc., established a camp in the vicinity of Neeah Bay, and fished continuously throughout the following winter on Flattery Bank and directly off Cape Flattery. They consider that they have given these grounds a thorough trial. Mr. Moor, one of the members of this party, came to the Pacific coast in the schooner *Mollie Adams* and remained with her during the trips made by that vessel in the summer of 1888 to Flattery Bank and to the Queen Charlotte Islands and Sound. He has furnished a synopsis of last winter's fishing. They first set trawls November 23, 1888, and from that date up to January 7, 1889, succeeded in landing 2,076 pounds of halibut and 244 pounds of cultus-cod. The average weight of the halibut was 37 pounds and of the cultus-cod 24 pounds. After January 7 little was done, owing to the scarcity of fish and bait and the prevalence of stormy weather.

Mr. Moor does not think it advisable to send vessels to Flattery Bank earlier than the 1st of March nor later than the 1st of September. He thinks that halibut are abundant from March to June, but do not occur in incredible numbers, as has been reported from time to time.

In November, 1888, Capt. Silas Calder, then of the schooner *Mollie Adams*, made a series of trials for halibut on Flattery Bank, but did not secure a single specimen. He is of the opinion that vessels could obtain good fares during a few months of each year, and might find the business profitable if there were a market for the catch. But as there are now no markets on the northwest coast that can take more than a few hundred pounds of the fish at a time, there is no incentive for vessel fishermen to engage in the industry.

Straits of Fuca.—There are a few fishermen about Port Townsend and Victoria, who fish for halibut and dogfish the greater part of the year. One of these, Mr. Isaac Bakman, with whom I conversed, stated that he did not think that halibut were ever abundant enough in the Straits of Fuca to warrant vessels of large size engaging in the business. In April, 1888, Mr. Bakman secured in different parts of the straits 4,500 pounds of halibut, for which he received from 2 to 3 cents per pound. These spring fish have been very scarce, and not enough have been caught to pay expenses.

Puget Sound.—During the winter of 1888 and 1889 three men were occupied in Puget Sound in fishing for cod with gill nets and trawl lines. No large quantities of these fish were obtained, but many flounders and a few halibut were taken on the trawls. The fishermen claim that on the "dark" of the moon cod work inshore, and as it begins to grow they move off again into deeper water. They are captured in depths of 5 to 100 fathoms. The deepest water in which cod gill nets have been set is 150 fathoms, off Quartermaster Harbor, near the head of Puget Sound.

None of the salmon canneries had commenced operations at the time of our arrival at Seattle. Salmon are not expected to run before the latter part of July or the 1st of August. Messrs. Felton and Kirkwood, constituting the King County Packing Company, intended to put down this coming season from 8 to 12 traps, costing from $400 to $800 each, according to size, including the boats and all other gear. They also have two purse seines valued at $1,200 each.

Beshowe or Black-Cod Fishery.—In the fall of 1888, several merchants of Victoria, Vancouver Island, talked of fitting out and sending vessels to the black-cod grounds off the west coast of the Queen Charlotte Islands. I have received information of only one such vessel, which has been fishing since November, 1888, in the vicinity of Gold Harbor, Queen Charlotte Islands. It was stated that she had shipped about 70 barrels of black cod to Victoria since she began fishing. These fish were caught in 250 fathoms. The manner of dressing the black cod has not been changed during the year; they still split them

down the back, leaving the head and backbone attached, which causes the fish to rust very quickly. This method of preparation undoubtedly retards their sale in the markets; if cured like cod, or even mess mackerel, this delicious fish would be in far greater demand.

June 18, while at anchor in Port Orchard Bay, Puget Sound, we made several hauls with the seine, securing among other species a small quantity of herring.

REPORT OF ENSIGN MARBURY JOHNSTON, U. S. N., NAVIGATOR.

During the year ending June 30, 1889, the cruising of the *Albatross* has been comprised between the parallels of 17° and 59° north latitude and the meridians of 110° and 167° west longitude. The following table gives the number of days under way, together with the distances run and the object of each trip:

Dates.	Miles.	Object.
July 4 to July 8	739	San Francisco, Cal., to Esquimalt, British Columbia.
July 9	79	Esquimalt to Departure Bay, British Columbia.
July 11 to July 23	1,961	Departure Bay to Unalaska, sounding and dredging.
July 28 to July 31	417.5	Unalaska to Popof Island, sounding, dredging, and fishing.
Aug. 2 to Aug. 10	1,012	Popof Island to Old Harbor, Kadiak Island, sounding, dredging, and fishing.
Aug. 12 to 14	266.5	Old Harbor to St. Paul, Kadiak, sounding, dredging, and fishing.
Aug. 21 to Sept. 3	1,780.5	St. Paul to Departure Bay, British Columbia, sounding, dredging, and fishing.
Sept. 5 to Sept. 6	139	Departure Bay to Seattle, Wash., sounding, dredging, and fishing.
Sept. 17 to Sept. 26	851.5	Seattle to Barclay Sound, British Columbia, sounding, dredging, and fishing.
Sept. 29 to Sept. 30	149.5	Barclay Sound to Seattle, Wash., sounding, dredging, and fishing.
Oct. 4	38	Seattle, Wash., to Port Townsend, Wash.
Oct. 6	35	Port Townsend, Wash., to Victoria, British Columbia.
Oct. 7	76	Victoria to Departure Bay, British Columbia.
Oct. 10 to Oct. 14	531.4	Departure Bay to Astoria, Oregon, sounding, dredging, and fishing.
Oct. 18 to Oct. 21	575.5	Astoria to San Francisco, Cal., sounding, dredging, and fishing.
Jan. 3 to Jan 10	546.4	San Francisco to San Diego, Cal., sounding, dredging, and fishing.
Jan. 15 to Jan. 19	344.8	Sounding, dredging, and fishing.
Jan. 23 to Jan. 26	303.1	Sounding, dredging, and fishing.
Feb. 4 to Feb. 9	384.6	Sounding, dredging, and fishing
Feb. 11 to Feb. 14	249.9	Sounding, dredging, and fishing.
Feb. 26 to Mar. 4	936	San Diego to Clarion Island, sounding, dredging, and fishing.
Mar. 6 to Mar. 8	241.5	Clarion Island to Socorro Island, sounding, dredging, and fishing.
Mar. 10 to Mar. 12	385.6	Socorro Island to Pichilinque Bay, Lower California, sounding, dredging, and fishing.
Mar. 16 to Mar. 21	303.4	Pichilinque Bay to Guaymas, Mex., sounding, dredging, and fishing.
Mar. 23 to Mar. 30	679.3	Cruising in Gulf of California, sounding, dredging, and fishing.
Mar. 31 to Apr. 3	270.9	Guaymas to La Paz, Lower California, sounding, dredging and fishing.
Apr. 6 to Apr. 8	338.7	La Paz to Magdalena Bay, Lower California, sounding, dredging, and fishing.
Apr. 9 to Apr. 11	272.5	Magdalena Bay to San Bartolome Bay, sounding and dredging.
Apr. 12 to Apr. 14	345.5	Bartolome Bay to San Diego, Cal., sounding and dredging.
Apr. 22 to Apr. 25	454	San Diego, Cal., to San Francisco, Cal.
May 21 to May 25	813.5	San Francisco, Cal., to Departure Bay, British Columbia.
May 26 to May 27	70.	Departure Bay to Victoria, British Columbia.
May 29	33.	Victoria to Port Townsend, Wash.
May 30	38.	Port Townsend to Seattle, Wash.
June 6 to June 10	628.	Seattle to Astoria, Oreg., sounding, dredging, and fishing.
June 13 to June 15	338.	Astoria to Seattle, Wash., sounding, dredging, and fishing.
June 18 to June 19	22.5	Cruising in Puget Sound, sounding, dredging, and fishing.
June 24	38	Seattle to Port Townsend, Wash.
June 27 to June 30	437	Port Townsend to Departure Bay, sounding and dredging.
168 days	17,124.6	

The total number of days at sea was 168, and the distance traveled 17,124.6 miles. During this time 965 soundings were taken, of which number 237 were also dredging stations.

The deviation of the standard compass was found to increase rapidly on easterly and westerly courses with an increase of latitude, the points of no deviation remaining constant at about N. by W. and S. ½ E.

The ship was swung for compass observations on the following dates:

Date.	Position.			
	Lat. N.		Long. W.	
	°	′	°	′
July 7	45	38	124	00
August 3	55	00	160	15
August 22	58	00	151	30
January 6	34	00	120	20

Compass cards showing graphically the amount of deviation on each point are appended.

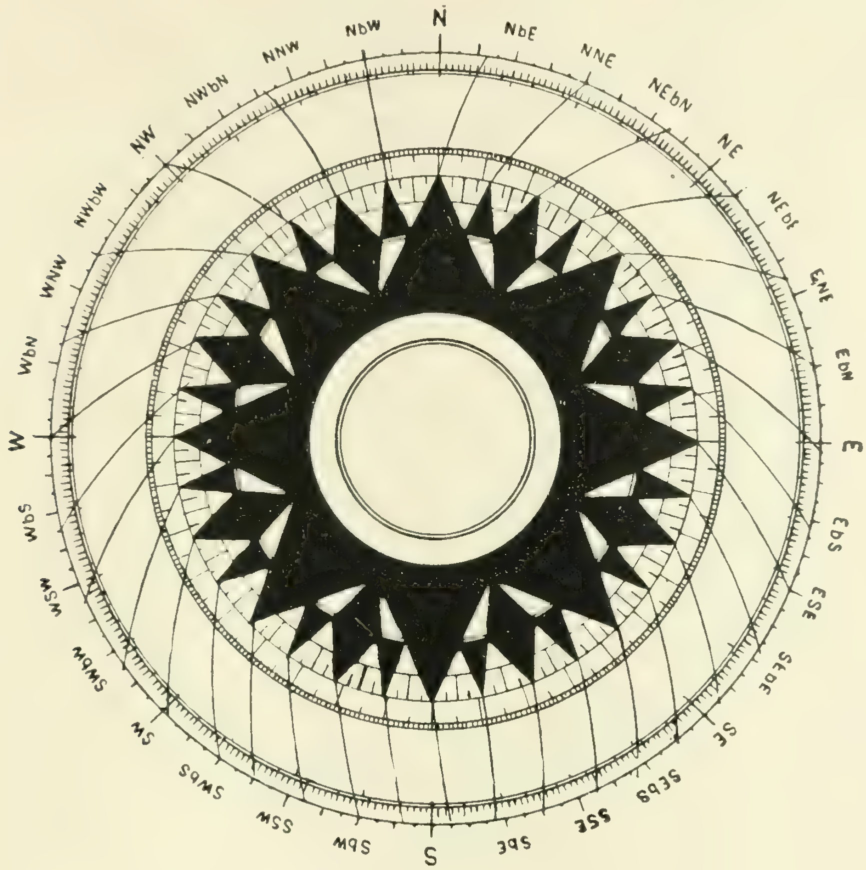
On March 28 a survey was made of Willard Bay, on the west side of the Gulf of California. The base line was obtained in the following manner: The two extremities of the line were occupied by observers, who measured simultaneously the angle subtended by the foremast of the *Albatross*. One observer also measured the horizontal angle between the foremast and the other observer. The height of the foremast being known, the distance from the ship of each observer was computed. Then with the measured horizontal angle and the two computed distances, the third side of the triangle—the base line—was computed. From the two stations at the ends of the base line cuts were taken on all the prominent points. Willard's Point, the northern point of the bay, was also occupied, and a third round of angles taken as a check.

The astronomical bearing of the base line was obtained by two methods, the results agreeing very closely. The first was by compass bearing, applying the local variation as taken from the chart. The second by measuring the angle made by the intersection of the base line and a true north and south line. The latter was obtained by observing the shadow cast by a perpendicular stake 10 feet high at apparent noon. The latitude was obtained by observing the meridian altitude of the sun with a sextant and artificial horizon; the longitude, by equal altitudes of the sun observed before and after noon. The mean of four chronometers, rated at San Diego 32 days previously, was taken in making the computation.

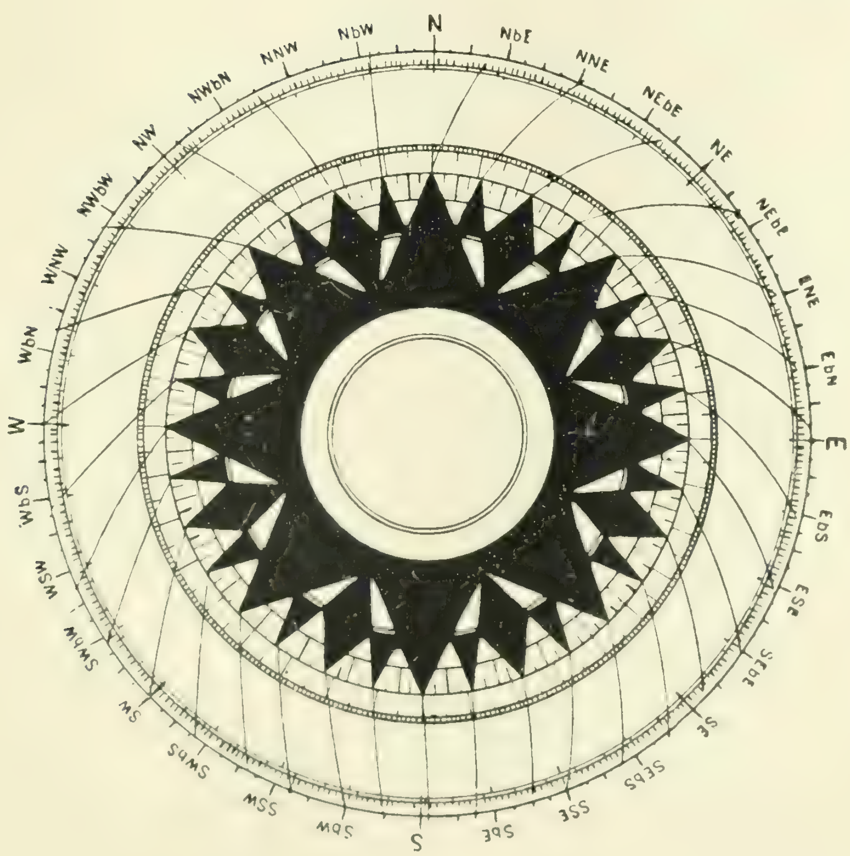
Several zigzag lines of sounding were run in the northern portion of the bay, but lack of time prevented a thorough examination of the bottom.

The angles were all measured with a sextant, the ship having no theodolite on board.

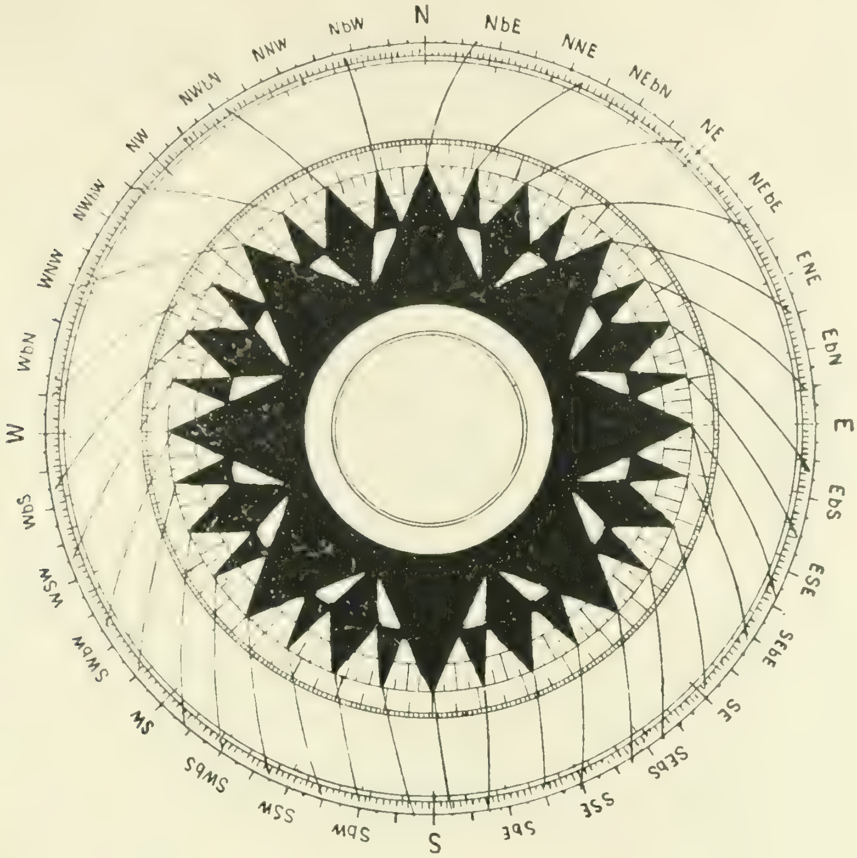
The four chronometers in use on board this vessel were last cleaned and overhauled in August, 1887. They run well together, and as yet show no indications of needing attention.



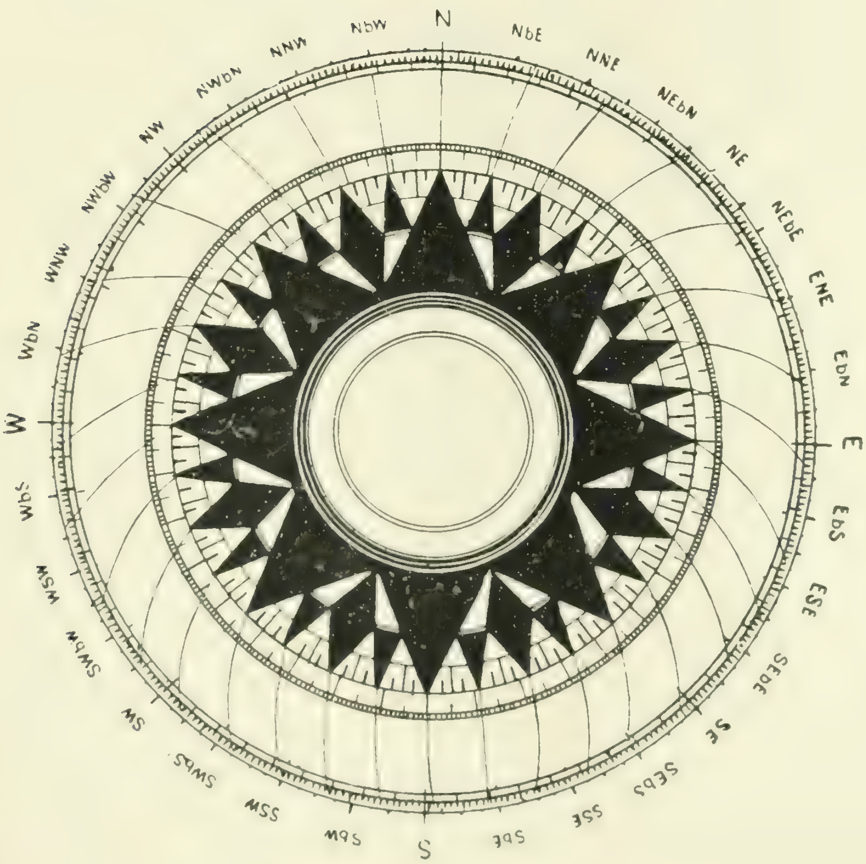
Steering Card.
Latitude 45° 38′ N.; Longitude 124° 00′ W.



Steering Card.
Latitude 55° 00′ N.; Longitude 160° 15′ W.



STEERING CARD.
Latitude 58° 00′ N.; Longitude 151° 30′ W.



STEERING CARD.
Latitude 34° 00′ N.; Longitude 120° 20′ W.

TABLES.

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, to June 30, 1889.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bot.	Kind of reel.	Weight of sinker.
	1888.		° ′ ″	° ′ ″	Fms.		°F.	°F.	°F.		Lbs.
1130	July 19	6:16 a. m.	52 15 00	156 37 00	2, 550	br. oz	51	51	34.9	Baird	60
1131	...do ...	2:36 p. m.	52 12 00	158 20 00	2, 581	Wire carried away.	51	49		...do	60
1132	.. do ...	10:29 p. m.	52 15 00	160 00 00	2, 558	gy. oz. P	50	48	35	...do	60
1133	July 20	6:33 a. m.	52 15 00	161 40 30	2, 573	Wire carried away.	51	50		...do	60
1134	...do ..	11:57 a. m.	52 17 00	162 48 00	2, 678	gy. oz	55	51	35.2	...do	60
1135	...do ...	5:33 p. m.	52 18 00	163 54 00	2, 848	gy. oz	54	50	35.2	...do	60
1136	...do ...	11:46 p. m.	52 20 00	165 00 00	3, 820	gy. oz	52	50	35.7	...do	60
1137	July 21	6:14 a. m.	52 20 00	166 05 00	2, 654	gy. oz	55	50	35.2	.. do	60
1138	...do ...	10:03 a. m.	52 40 00	166 35 00	2, 267	gy. oz	52	51	35.2	...do	60
1139	...do ...	12:07 p. m.	52 53 00	166 44 00	1, 961	gy. oz	52	50	35.2	...do	38
1140	...do ...	2:19 p. m.	53 05 00	166 49 00	169	bk. S	53	50	41.2	...do	38
1141	...do ...	3:06 p. m.	53 11 00	166 51 00	84	bk. S. P	52	50	40.6	Tanner	25
1142	...do ...	4:08 p. m.	53 17 00	166 54 00	57	S. bk. sp	54	50		...do	25
1143	...do ...	5:08 p. m.	53 22 00	166 55 30	41	S. bk. sp	54	50	42.7	...do	25
1144	...do ...	5:31 p. m.	53 23 00	166 56 00	28	S. bk. sp	54	50	42.2	...do	25
1145	...do ...	6:40 p. m.	53 19 00	166 50 00	55	bk. S. P	51. 5	48	41.7	...do	25
1146	...do ...	8:28 p. m.	53 17 00	166 42 00	58	gy. S	51	48	41.2	...do	25
1147	..do ...	9:11 p. m.	53 15 00	166 35 00	83	bk. S	51	48	41.2	...do	25
1148	..do ...	9:58 p. m.	53 13 00	166 27 00	174	bk. S	51	49	41.2	...do	25
1149	...do ...	11:27 p. m.	53 16 00	166 10 00	228	bk. S	51	49	39.5	Baird	38
1150	July 22	1:01 a. m.	53 25 00	166 02 30	94	crs. bk. S	51	49	41.2	Tanner	25
1151	...do ...	2:25 a. m.	53 27 00	165 46 00	113	crs. bk. S. P	51	49	41.2	...do	25
1152	...do ...	3:47 a. m.	53 30 00	165 30 00	261	gr. m	51	49	39.7	Baird	38
1153	...do ...	5:16 a. m.	53 37 00	165 18 30	99	gy. S. P	50	48	40.7	...do	38
1154	...do ...	6:39 a. m.	53 39 00	165 04 00	133	fne. gy. S	50	48	41.2	Tanner	25
1155	...do ...	8:05 a. m.	53 42 00	164 46 00	163	bk. S	50	49	40.2	...do	25
1156	...do ...	9:34 a. m.	53 48 00	164 32 00	66	bk. S. G	59	49	40.2	...do	25
1157	...do ...	10:23 a. m.	53 43 00	164 38 00	111	bk. S. Sh	52	49	40.7	...do	25
1158	..do ...	11:20 a. m.	53 43 00	164 31 00	73	bk. S. fne. G	52	50	40.7	...do	25
1159	...do ...	12:14 p. m.	53 39 00	164 34 00	185	lt. S	52	50	40.2	...do	25
1160	..do ...	1:03 p. m.	53 39 00	164 26 00	211	gy. S. bk. Sp	52	50	40.1	.. do	25
1161	.. do ...	1:47 p. m.	53 41 30	164 20 00	89	bk. S	52	50	40.5	..do	25
1162	...do ...	2:32 p. m.	53 43 00	164 13 00	68	gy. S. bk. Sp. P.	52	50	40.4	.. do	25
1163	...do ...	3:16 p. m.	53 42 30	164 05 00	63	gy. S. bk. Sp	51	49	40.4	..do	25
1164	...do ...	4:01 p. m.	53 42 00	163 57 30	95	gr. M	51	49	40 2	. do	25
1165	.. do ...	5:17 p. m.	53 51 00	163 51 00	43	bk. S	51	49	40.2	.. do	25
1166	...do ...	6:39 p. m.	54 00 00	163 45 00	45	fne. gy. S	51	50	41.7	.. do	25
1167	..do ...	9:24 p. m.	54 09 00	163 41 00	45	bk. S. bk. Sp	51	50	41.2	..do	25
1168	...do ...	11:31 p. m.	54 13 00	164 02 00	51	R. fine. G	51	49	39.2	.. do	25
1169	July 23	1:21 a. m.	54 16 00	164 23 00	56	gy. S. bk. Sp	52	49	41.2	...do	25
1170	...do ...	2:37 a. m.	54 18 00	164 38 00	45	gy. S. bk. Sp	52	50	42.2	...do	25
1171	...do ...	3:29 a. m.	54 20 00	164 49 00	30	G	51	48	43.9	...do	25
1172	...do ...	4:31 a. m.	54 22 00	165 00 00	42	crs. bk. S. G	51	48	45.2	...do	25
1173	...do ...	5:12 a. m.	54 23 00	165 09 00	72	crs. bk. S	50	45	42.2	...do	25
1174	...do ...	6:54 a. m.	54 25 00	165 19 00	80	bk. S	50	45	40.7	.. do	25
1175	...do ..	6:36 a. m.	54 24 00	165 25 00	85	bk. S. G	50	45	40.2	...do	25
1176	...do ..	7:18 a. m.	54 22 00	165 34 30	73	bk. S. G	48	44	40.7	...do	25
1177	.. do ..	7:54 a. m.	54 21 00	165 41 00	51	bk. S. G	51	45	41.2	...do	25
1178	...do ...	8:38 a. m.	54 19 00	165 49 00	53	P	51	45	41.2	...do	25
1179	July 28	11:39 a. m.	53 56 00	166 07 00	36	bk. S. brk. Sh	48	49	44.4	.. do	25
1180	. do ..	2:18 p. m.	53 56 00	165 48 00	51	brk. Sh. G	52	46	43.2	...do	25
1181	...do ..	4:53 p. m.	53 55 30	165 22 00	57	bk. S	51	48	41.2	...do	25
1182	...do ...	6:17 p. m.	53 55 00	165 05 30	53	bk. S. G	52	52	43.2	...do	25
1183	...do ...	7:40 p. m.	54 00 00	164 51 00	59	brk. Sh. P	51	51	44.2	.. do	25
1184	.. do ...	10:14 p. m.	53 58 00	164 39 00	61	gy. S. G	49	50	41.2	.. do	25
1185	.. do ...	11:33 p. m.	53 55 00	164 22 00	50	crs bk. S	50	50	40.2	..do	25
1186	July 29	12:59 a. m.	53 53 00	164 05 00	45	gy. S	51	50	41.2	...do	25
1187	...do ...	3:23 a. m.	53 49 00	163 40 00	342	bk. S	51	50	39.2	Sigsbee	60
1188	...do ...	5:00 a. m.	54 00 00	163 37 00	62	bk. S	52	51	41.2	Tanner	25
1189	...do ...	5:46 a. m.	54 01 00	163 45 00	49	bk. S	52	51	40.2	...do	25
1190	...do ...	6:30 a. m.	54 02 00	163 53 30	48	bk. S	52	51	41.7	...do	25
1191	...do ...	7:11 a. m.	54 04 00	164 01 00	46	bk. S	52	51	42.2	...do	25
1192	...do ...	9:31 a. m.	54 06 00	164 17 00	41	bk. S. G	53	51	43.2	...do	25
1193	...do ...	10.14 a. m.	54 08 00	164 25 00	52	bk. S	53	51	42.2	...do	25
1194	...do ...	11:03 a. m.	54 09 00	164 33 00	52	bk. S. G	52	50	41.2	...do	25
1195	...do ...	11:48 a. m.	54 10 00	164 42 00	49	brk. Sh	51	50	41.2	...do	25
1196	...do ..	12:21 p. m.	54 11 00	164 48 00	52	rky	51	50	43.2	...do	25
1197	...do ...	1:05 p. m.	54 15 00	164 41 00	71	crs. bk. S	50	51	40.7	.. do	25
1198	...do ...	3:20 p. m.	54 25 00	164 21 00	63	R. bk. S	52	51	40.6	...do	25

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, *to June* 30, 1889—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bot.	Kind of reel.	Weight of sinker.
	1888.		° ′ ″	° ′ ″	*Fms.*		°F.	°F.	°F.		*Lbs.*
1199	July 29	6:20 p. m.	54 22 00	164 01 00	55	bk. S	51	49	41.2	Tanner	25
1200	...do ...	8:30 p. m.	54 20 00	163 41 00	72	bk. S	51	49	40.2	...do	25
1201	...do ...	10:40 p. m.	54 18 00	163 21 00	44	bk. S. G	51	50	40.2	...do	25
1202	...do ...	11:19 p. m.	54 18 00	163 18 00	32	rky	51	50	42.2	...do	25
1202a	...do ...	...do	54 16 00	163 19 30	28	No specimen	51	50	.....	....	....
1202b	...do ...	...do	54 15 00	163 21 00	25	No specimen	51	50	.....	....	....
1203	July 30	12:44 a. m.	54 14 00	163 21 30	39	gy. S. bk. Sp	51	50	40.2	Tanner	25
1204	...do ...	2:12 a. m.	54 10 00	163 24 00	42	gy. S. bk. Sp	51	51	42.3	...do	25
1205	...do ...	4:48 a. m.	54 09 00	163 14 00	44	bk. S. G	50	50	42.2	...do	25
1206	...do ...	5:33 a. m.	54 09 00	163 04 00	43	G	51	50	42.2	...do	25
1207	...do ...	5:58 a. m.	54 09 00	162 58 00	43	bk. S	51	50	.....	...do	25
1208	...do ...	6:18 a. m.	54 08 00	162 54 00	41	gy. S. bk. Sp	51	50	42.2	...do	25
1209	...do ...	8:59 a. m.	54 03 00	162 43 00	51	G	51	50	41.2	...do	25
1210	...do ...	9:49 a. m.	53 58 00	162 42 00	464	rky	51	50	42.2	...do	25
1211	...do ...	10:55 a. m.	54 03 00	162 33 00	265	rky	51	50	39.2	...do	25
1212	...do ...	11:55 a. m.	54 08 00	162 22 00	60	crs. S. P	51	50	40.2	...do	25
1213	...do ...	12:40 p. m.	54 12 00	162 17 00	47	bk. S. fne. G	51	50	42.2	...do	25
1214	...do ...	2:06 p. m.	54 09 00	162 10 00	67	rky	51	51	40.2	...do	25
1215	...do ...	2:52 p. m.	54 12 00	162 02 00	51	rky. fne. G	51	50	41.2	...do	25
1216	...do ...	3:40 p. m.	54 16 00	161 53 00	37	rky	51	50	42.2	...do	25
1217	...do ...	4:28 p. m.	54 20 00	161 46 00	38	P	51	50	40.7	...do	25
1218	...do ...	5:14 p. m.	54 26 00	161 45 00	80	gr. M	52	50	39.8	...do	25
1219	...do ...	5:56 p. m.	54 31 00	161 44 00	82	gr. M	52	50	40.2	...do	25
1220	...do ...	6:49 p. m.	54 34 00	161 48 00	58	rky	52	50	41.2	...do	25
1221	...do ...	7:57 p. m.	54 27 00	161 53 00	81	gr. M	51	49	40.2	...do	25
1222	...do ...	9:32 p. m.	54 32 00	161 39 00	81	rky	51	49	40.2	...do	25
1223	...do ...	11:51 p. m.	54 37 00	161 27 00	59	bk. S	51	49	41.7	...do	25
1224	July 31	12:13 a. m.	54 42 00	161 13 00	64	bk. S	51	49	42.2	...do	25
1225	...do ...	1:40 a. m.	54 47 00	161 00 00	47	bk. S. G	51	49	42.2	...do	25
1226	...do ...	4:55 a. m.	54 51 00	160 47 00	45	gy. S. P	51	49	.....	...do	25
1227	...do ...	6:17 a. m.	54 56 00	160 33 00	52	gy. S	51	50	41.8	...do	25
1228	...do ...	7:25 a. m.	54 59 00	160 26 00	60	gy. S	51	51	41.7	...do	25
1229	Aug. 2	9:14 a. m.	55 08 00	160 05 00	18	fne. Gy. S	51	49	40.9	...do	25
1230	Aug. 3	6:37 a. m.	55 04 00	160 26 00	34	brk. Sh	58	51	45.7	...do	25
1231	...do ...	7:46 a. m.	55 05 00	160 42 00	38	rky	54	51	44.2	...do	25
1232	...do ...	9:03 a. m.	55 00 00	160 56 00	71	dk. M	53	52	40.2	Tanner	25
1233	...do ...	10:18 a. m.	54 52 00	161 17 00	74	dk. M	54	51	41.7	...do	25
1234	...do ...	11:35 a. m.	54 47 00	161 26 00	41	rky	54	51	43.2	...do	25
1235	...do ...	11:57 a. m.	54 44 00	161 27 00	45	rky	52	51	.....	...do	25
1236	...do ...	1:13 p. m.	54 38 00	161 39 00	49	bk. S. G	52	51	43.2	...do	25
1237	...do ...	2:32 p. m.	54 32 00	161 53 00	75	bk. S	52	51	41.2	...do	25
1238	...do ...	3:53 p. m.	54 25 00	162 05 00	63	bk. S	52	51	40.2	...do	25
1239	...do ...	4:45 p. m.	54 23 00	161 56 00	34	P	51	51	43.5	...do	25
1240	...do ...	5:55 p. m.	54 20 00	162 02 00	30	Sh	51	50	43	...do	25
1241	...do ...	6:39 p. m.	54 16 00	162 08 00	40	brk. Sh. G	52	50	42.2	...do	25
1242	...do ...	8:33 p. m.	54 07 00	162 07 00	435	dk. M	51	50	38.2	Sigsbee	38
1243	...do ...	9:35 p. m.	54 10 00	161 54 00	52	rky	52	50	39.7	...do	38
1244	...do ...	10:21 p. m.	54 13 00	161 47 00	50	bk. S. P	52	51	40.2	Tanner	25
1245	...do ...	11:04 p. m.	54 17 00	161 40 00	44	crs. S	52	51	41.7	...do	25
1246	...do ...	11:44 p. m.	54 18 00	161 34 00	42	S. R	52	51	42.2	...do	25
1247	Aug. 4	1:05 a. m.	54 22 00	161 22 00	61	R. G	52	51	41.2	...do	25
1248	...do ...	2:17 a. m.	54 27 00	161 08 00	59	bk. S	52	50	41.2	...do	25
1249	...do ...	3:31 a. m.	54 31 00	160 54 00	71	bk. S	52	50	40.2	...do	25
1250	...do ...	4:48 a. m.	54 35 00	160 41 00	72	bu. M	52	51	40.2	...do	25
1251	...do ...	6:04 a. m.	54 39 00	160 28 00	62	gy. S. P	52	50	40.4	...do	25
1252	...do ...	7:24 a. m.	54 43 00	160 14 00	50	fne. gy. S	53	51	40.6	...do	25
1253	...do ...	8:34 a. m.	54 47 00	160 00 00	43	gy. S. bk. Sp	53	51	42.2	...do	25
1254	...do ...	9:21 a. m.	54 49 00	159 54 00	40	fne. gy. S	53	51	43.7	...do	25
1255	...do ...	12:08 p. m.	54 57 00	159 55 00	25	gy. S	51	50	48.3	...do	25
1256	...do ...	12:48 p. m.	55 00 00	159 54 00	27	rky	51	50	45.2	...do	25
1257	...do ...	1:24 p. m.	54 59 00	159 45 00	26	bk. S. P	51	50	45.2	...do	25
1258	...do ...	2:15 p. m.	55 02 00	159 41 00	37	gy. S. brk. Sh	53	50	44.7	...do	25
1259	...do ...	3:00 p. m.	55 06 00	159 39 00	57	S. brk. Sh	53	48	44.2	...do	25
1260	...do ...	3:30 p. m.	55 10 00	159 40 00	39	S. brk. Sh	53	48	44.2	...do	25
1261	...do ...	5:13 p. m.	55 15 00	159 28 00	23	R. C	53	48	42.0	...do	25
1262	Aug. 5	4:49 a. m.	55 03 00	159 15 00	27	brk. Sh	51	49	45.7	...do	25
1263	...do ...	5:29 a. m.	55 01 00	159 08 00	44	G	51	49	43.2	...do	25
1264	...do ...	6:05 a. m.	54 59 00	159 00 00	48	gy. S	51	49	42.2	...do	25
1265	...do ...	6:42 a. m.	54 57 00	158 52 00	43	gy. S. G	51	49	42.2	...do	25
1266	...do ...	7:13 a. m.	54 55 00	158 46 00	46	gy. S. brk. Sh	51	49	42.2	...do	25
1267	...do ...	8:13 a. m.	54 53 00	158 38 00	70	gy. S	52	51	40.2	...do	25
1268	...do ...	9:01 a. m.	54 49 00	158 42 00	56	gy. S. P	51	51	40.9	...do	25
1269	...do ...	9:46 a. m.	54 51 00	158 49 00	46	gy. S. brk. Sh	51	51	42.2	...do	25
1270	...do ...	10:07 a. m.	54 52 00	158 54 00	45	rky	51	51	...	Bassnet	25
1271	...do ...	10:31 a. m.	54 53 00	158 57 00	41	S. R	51	51	42.7	Tanner	25
1272	...do ...	10:55 a. m.	54 54 00	159 01 00	45	rky	51	52	.....	Bassnet	25

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bot.	Kind of reel.	Weight of sinker.
	1888.		° ′ ″	° ′ ″	*Fms.*		°F.	°F.	°F.		*Lbs.*
1273	Aug. 5	11:16 a. m.	54 55 00	159 05 00	35	rky	52	52	43.2	Tanner	25
1274	...do...	11:38 a. m.	54 52 00	159 07 00	38	gy. S. P. brk. Sh	52	52	...	Bassnet	25
1275	...do...	11:58 a. m.	54 50 00	159 08 30	35	rky	52	52	44.2	Tanner	25
1276	...do...	12:19 p. m.	54 49 00	159 05 00	57	rky	52	52	.....	Bassnet	25
1277	...do...	12:38 p. m.	54 48 00	159 01 00	44	Sh. fne. G	52	52	43.2	...do	25
1278	...do...	1:04 p. m.	54 47 00	158 55 00	47	R. Sh	54	51	42.2	Tanner	25
1279	...do...	1:22 p. m.	54 46 00	158 53 00	49	R	54	51	42.5	...do	25
1280	...do...	2:01 p. m.	54 44 00	158 44 00	55	rky	54	51	41.7	...do	25
1281	...do...	3:18 p. m.	54 35 00	158 51 00	99	bu. M. P	54	51	40.7	...do	25
1282	...do...	4:04 p. m.	54 37 00	158 58 00	69	gy. S. P	54	51	40.2	...do	25
1283	...do...	4:39 p. m.	54 38 00	159 02 00	56	gy. S. P	53	51	41.3	do	25
1284	...do...	5:27 p. m.	54 39 00	159 09 00	46	P	53	51	42.5	Tanner	25
1285	...do...	6:07 p. m.	54 41 00	159 16 00	41	gy. S. Sh	53	51	43.2	...do	25
1286	...do...	7:48 p. m.	54 42 00	159 24 00	35	rky	51	49	44.2	...do	25
1287	...do...	7:55 p. m.	54 41 00	159 29 30	35	rky	51	49	44.2	...do	25
1288	...do...	8:37 p. m.	54 37 00	159 25 00	43	rky	51	49	.....	Bassnet	25
1289	...do...	9:52 p. m.	54 32 00	159 17 00	115	rky	51	51	.....	Tanner	25
1290	...do...	11:53 p. m.	54 25 00	159 40 00	105	bk. S	50	50	41.2	...do	25
1291	Aug. 6	1:16 a. m.	54 36 00	159 39 00	49	bk. S	50	51	42.4	...do	25
1292	...do...	1:57 a. m.	54 41 00	159 39 00	42	P	50	51	43.0	...do	25
1293	...do...	2:45 a. m.	54 42 00	159 47 00	44	R	50	51	43.2	...do	25
1294	...do...	3:29 a. m.	54 37 00	159 52 00	49	R. gy. S.	50	51	42.2	...do	25
1295	...do...	4:51 a. m.	54 28 00	160 00 00	67	P	50	51	40.6	...do	25
1296	...do...	5:25 a. m.	54 25 00	160 03 00	119	fne. gy. S.	50	51	41.2	...do	25
1297	...do...	12:48 p. m.	54 39 00	158 43 00	52	rky	58	51	41.2	...do	25
1298	...do...	1:23 p. m.	54 40 00	158 35 00	57	rky	55	51	40.7	...do	25
1299	...do...	2:04 p. m.	54 41 00	158 25 00	86	P	54	53	41.2	...do	25
1300	...do...	2:45 p. m.	54 46 00	158 22 00	110	gy. S	54	53	41.2	...do	25
1301	...do...	3:30 p. m.	54 50 00	158 30 00	87	gy. S	54	53	41.2	...do	25
1302	...do...	4:12 p. m.	54 56 00	158 30 00	90	G	55	53	40.4	...do	25
1303	...do...	4:54 p. m.	55 01 00	158 30 00	114	gr. M	53	53	40.6	...do	25
1304	...do...	5:37 p. m.	55 03 00	158 38 00	87	G	53	52	39.9	...do	25
1305	...do...	6:15 p. m.	55 04 00	158 48 00	79	gy. S	53	52	40.4	...do	25
1306	...do...	6:55 p. m.	55 07 00	158 55 00	50	gy. S	51	50	41.5	...do	25
1307	...do...	7:36 p. m.	55 09 00	159 03 00	47	gy. S. P	51	50	41.9	...do	25
1308	...do...	8:17 p. m.	55 11 00	159 11 00	53	gy. S	52	51	43.2	...do	25
1309	...do...	8:59 p. m.	55 13 00	159 18 00	58	gy. S	51	51	42.2	...do	25
1310	...do...	9:43 p. m.	55 17 00	159 19 00	102	bu. M	51	51	40.4	...do	25
1311	...do...	11:06 p. m.	55 18 00	159 02 00	103	bu. M	51	51	40.2	...do	25
1312	Aug. 7	12:27 a. m.	55 20 00	158 45 00	97	gy. S	51	51	41.2	...do	25
1313	...do...	1:47 a. m.	55 21 00	158 29 00	80	gy. S	50	52	40.2	...do	25
1314	...do...	3:10 a. m.	55 22 00	158 12 00	68	M	50	52	...	...do	25
1315	...do...	4:31 a. m.	55 23 00	157 55 00	56	G. brk. Sh	50	50	42.1	...do	25
1316	...do...	5:48 a. m.	55 25 00	157 37 00	46	yl. S	51	50	42.0	...do	25
1317	...do...	6:25 a. m.	55 26 00	157 28 00	47	gn. M	51	50	42.1	...do	25
1318	...do...	8:21 a. m.	55 30 00	157 41 00	53	gy. S. G	50	50	41.9	...do	25
1319	...do...	9:38 a. m.	55 34 00	158 00 00	73	fne. gy. S	51	51	40.1	...do	25
1320	...do...	10:53 a. m.	55 39 00	158 14 00	73	M. fne. gy. S	51	51	42.1	...do	25
1321	...do...	12:07 p. m.	55 47 00	158 27 00	64	fne. gy. S	51	51	41.9	...do	25
1322	...do...	1:23 p. m.	55 54 00	158 40 00	68	bu. M	53	51	43.1	...do	25
1323	...do...	2:03 p. m.	55 57 00	158 47 00	82	bu. M	53	52	42.1	...do	25
1324	Aug. 8	6:56 a. m.	55 52 00	158 29 00	67	fne. Gy. S	52	50	42.1	...do	25
1325	...do...	8.00 a. m.	55 49 00	158 12 00	44	Sh. G	53	51	43.3	...do	25
1326	...do...	9:15 a. m.	55 47 00	157 55 00	57	gy. S	53	51	44.3	...do	25
1327	...do...	10:28 a. m.	55 45 00	157 39 00	67	fne. bk. S	54	53	41.3	...do	25
1328	...do...	11:08 a. m.	55 44 00	157 30 00	59	br. S	54	53	41.5	...do	25
1329	...do...	12:24 p. m.	55 42 00	157 24 00	54	rky	54	53	.....	...do	25
1330	...do...	12:29 p. m.	55 41 00	157 24 00	49	br. S. G	54	53	....	...do	25
1331	...do...	4:48 p. m.	55 40 00	157 16 00	48	bk. S. G	56	52	43.9	...do	25
1332	...do...	5:27 p. m.	55 39 00	157 07 00	47	crs. gy. S	56	52	45.1	...do	25
1333	...do...	6:02 p. m.	55 37 00	156 57 00	50	gy. S.	54	51	42.9	...do	25
1334	...do...	6:36 p. m.	55 36 00	156 47 00	55	fne. gy. S	53	52	41.7	...do	25
1335	...do...	7:52 p. m.	55 34 00	156 30 00	135	gn. M	53	52	41.1	...do	25
1336	...do...	9:12 p. m.	55 44 00	156 19 00	137	bu. M	54	52	41.1	Tanner	25
1337	...do...	11:02 p. m.	55 53 00	156 06 00	119	bu. M	54	52	41.3	...do	25
1338	Aug. 9	12:20 a. m.	55 46 00	155 55 00	89	P	53	50	41.1	...do	25
1339	...do...	1:37 a. m.	55 39 00	155 44 00	60	rky	52	50	42.6	...do	25
1340	...do...	2:51 a. m.	55 32 00	155 32 00	96	gy. S. P	52	50	42.1	...do	25
1341	...do...	4:11 a. m.	55 39 00	155 27 00	57	gy. S	52	50	46.1	...do	25
1342	...do...	4:53 a. m.	55 47 00	155 22 00	26	gy. S	52	50	48.2	...do	25
1343	...do...	5:09 a. m.	55 49 00	155 20 00	27	gy. S. brk. Sp	52	50	48.0	...do	25
1344	...do...	6:14 a. m.	55 41 00	155 14 00	76	gy. S	50	48	41.9	...do	25
1345	...do...	6:59 a. m.	55 39 00	155 09 00	287	gy. S	50	48	38.9	...do	25
1346	...do...	8:17 a. m.	55 47 00	155 00 00	89	gy. S	52	52	41.6	...do	25
1347	...do...	9:25 a. m.	55 55 00	154 51 00	81	fne. br. S	55	54	41.3	...do	25
1348	...do...	10:08 a. m.	55 51 00	154 47 00	76	fne. gy. S	58	54	42.5	...do	25
1349	...do...	10:43 a. m.	56 04 00	154 44 00	60	fne. gy. S	58	54	41.5	...do	25

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bot.	Kind of reel.	Weight of sinker.
	1888.		° ′ ″	° ′ ″	Fms.		°F.	°F.	°F.		Lbs.
1350	Aug. 9	11:21 a. m.	56 07 00	154 38 00	37	gy. S	58	54	42.5	Tanner	25
1351	...do	12:43 p. m.	56 05 00	154 33 00	61	fne. gy. S	55	55	41.6	...do	25
1352	...do	1:25 p. m.	56 03 00	154 25 00	66	gy. S. P. Co	55	55	41.6	...do	25
1353	...do	4:03 p. m.	56 09 00	154 15 00	75	bk. S	55	53	41.9	...do	25
1354	...do	5:18 p. m.	56 18 00	154 10 00	54	gy. S. bk. Sp	54	53	43.1	...do	25
1355	...do	6:29 p. m.	56 28 00	154 05 00	28	gy. S	53	50	48.2	...do	25
1356	...do	7:09 p. m.	56 27 00	153 55 00	23	brk. Sh	53	52	48.0	...do	25
1357	...do	7:47 p. m.	56 24 00	153 47 00	52	bn. S	53	52	43.1	...do	25
1358	...do	9:01 p. m.	56 18 00	153 33 00	46	G	53	52	43.2	...do	25
1359	...do	9:40 p. m.	56 15 00	153 25 00	52	gy. S. P	54	53	41.4	...do	25
1360	...do	10:19 p. m.	56 12 00	153 18 00	88	fne. gy. S	54	53	41.5	...do	25
1361	...do	11:42 p. m.	56 23 00	153 24 00	36	Sh	54	52	44.5	...do	25
1362	Aug. 10	12:27 a. m.	56 28 00	153 26 00	45	gy. S. Sh	53	51	44.1	...do	25
1363	...do	1:09 a. m.	56 34 00	153 29 00	73	bu. M	52	51	41.1	...do	25
1364	...do	1:50 a. m.	56 35 00	153 19 00	53	gy. S. C	54	53	42.1	...do	25
1365	...do	2:33 a. m.	56 36 00	153 10 00	58	bu. M	54	51	42.6	...do	25
1366	...do	3:10 a. m.	56 37 00	153 00 00	49	bu. M	53	51	42.1	...do	25
1367	...do	3:49 a. m.	56 39 00	152 50 00	44	rky	53	51	42.1	...do	25
1368	...do	4:30 a. m.	56 40 00	152 40 00	51	gy. S	53	51	42.6	...do	25
1369	...do	5:08 a. m.	56 41 00	152 30 00	49	rky	53	51	42.1	...do	25
1370	...do	5:46 a. m.	56 42 00	152 21 00	37	S. P	54	52	43.3	...do	25
1371	...do	8:26 a. m.	56 46 00	152 35 00	61	S. P	66	54	41.9	...do	25
1372	...do	8:37 a. m.	56 51 00	152 50 00	37	gy. S. brk. Sh	66	54	44.7	...do	25
1373	...do	11:05 a. m.	56 58 00	153 10 00	18	brk. Sh	57	55	47.3	...do	25
1374	...do	1:09 p. m.	57 04 00	153 18 00	68	bk. M	57	55	43.2	...do	25
1375	...do	1:47 p. m.	57 07 00	153 18 00	57	br. M	57	55	44.1	...do	25
1376	Aug. 12	4:17 p. m.	56 55 00	153 19 00	71	fne. gy. S	54	53	43.8	...do	25
1377	...do	4:55 p. m.	56 51 00	153 13 00	111	gn. M	54	55	39.9	...do	25
1378	...do	6:03 p. m.	56 43 00	153 00 00	60	rky	53	54	40.9	...do	25
1379	...do	7:10 p. m.	56 35 00	152 48 00	46	S. P	53	54	41.9	...do	25
1380	...do	8:14 p. m.	56 28 00	152 36 00	38	P	52	53	42.6	...do	25
1381	...do	9:23 p. m.	56 20 00	152 23 00	347	gn. M	52	54	39.1	...do	25
1382	...do	10:53 p. m.	56 29 00	152 11 00	173	gy. S	52	54	40.1	...do	25
1383	Aug. 13	12:14 a. m.	56 38 00	151 59 00	28	rky	53	54	44.6	...do	25
1384	...do	12:52 a. m.	56 35 00	151 50 00	60	gy. S. R	53	54	42.1	...do	25
1385	...do	1:29 a. m.	56 33 00	151 42 00	298	gy. S	53	54	39.6	...do	25
1386	...do	2:40 a. m.	56 42 00	151 29 00	485	rky	53	54	39.1	...do	25
1387	...do	3:59 a. m.	56 49 00	151 42 00	58	gy. S	53	54	42.9	...do	25
1388	...do	5:12 a. m.	56 56 00	151 56 00	49	gy. S	53	53	44.8	...do	25
1389	...do	6:20 a. m.	57 03 00	152 10 00	44	rky	53	52	43.9	...do	25
1390	...do	7:27 a. m.	57 10 00	152 23 00	86	fne. gy. S	54	52	41.4	...do	25
1391	...do	8:08 a. m.	57 12 00	152 27 00	53	fne. gy. S	55	53	44.4	...do	25
1392	...do	9:07 a. m.	57 16 00	152 22 00	39	bn. S. G	55	50	45.3	...do	25
1393	...do	10:34 a. m.	57 20 00	152 15 00	25	rky	57	52	47.5	...do	25
1394	...do	1:36 p. m.	57 17 00	152 07 00	45	brk. Sh	52	49	44.6	...do	25
1395	...do	2:37 p. m.	57 11 00	151 52 00	43	gy. S. brk. Sh	52	49	45.1	...do	25
1396	...do	3:44 p. m.	57 05 00	151 37 00	46	Co	52	53	45.1	...do	25
1397	...do	4:51 p. m.	57 00 00	151 23 00	90	gy. S	56	53	41.4	...do	25
1398	...do	6:30 p. m.	57 11 00	151 05 00	75	gy. S	55	53	41.8	...do	25
1399	...do	7:39 p. m.	57 18 00	151 19 00	71	G	53	53	43.4	...do	25
1400	...do	8:46 p. m.	57 24 00	151 33 00	39	rky	52	50	45.5	...do	25
1401	...do	9:53 p. m.	57 30 00	151 46 00	57	rky	52	50	44.9	...do	25
1402	...do	10:31 p. m.	57 35 00	151 52 00	81	rky	52	50	42.9	...do	25
1403	Aug. 21	3:26 p. m.	57 43 00	152 14 00	69	bu. M	60	54	46.5	...do	25
1404	...do	3:52 p. m.	57 42 00	152 09 00	17	rky	60	54	......	...do	25
1405	...do	4:33 p. m.	57 46 00	152 01 00	28	Sh	57	53	48.5	...do	25
1406	...do	5:14 p. m.	57 49 00	151 53 00	56	gy. S. brk. Sh	57	53	44.6	...do	25
1407	...do	5:54 p. m.	57 52 00	151 47 00	47	gy. S	56	55	45.1	...do	25
1408	...do	6:34 p. m.	57 49 00	151 39 00	30	G. Sh	56	55	47.3	...do	25
1409	...do	7:14 p. m.	57 46 00	151 32 00	33	G. Sh	62	55	48.8	...do	25
1410	...do	7:46 p. m.	57 43 00	151 25 00	35	crs. gy. S. brk. Sh	56	52	48.1	...do	25
1411	...do	8:25 p. m.	57 39 00	151 18 00	38	Sh. Co	56	52	47.3	...do	25
1412	...do	9:08 p. m.	57 36 00	151 11 00	42	Sh	55	52	46.0	...do	25
1413	...do	10:22 p. m.	57 29 00	150 56 00	48	gy. S. Sh	54	53	44.3	...do	25
1414	...do	11:36 p. m.	57 23 00	150 41 00	57	gy. S	55	55	42.7	...do	25
1415	Aug. 22	12:18 a. m.	57 19 00	150 35 00	72	gy. S. P	55	56	41.6	...do	25
1416	...do	2:35 a. m.	57 26 00	150 06 00	200	gy. S. bk. Sp	56	57	39.6	...do	25
1417	...do	4:00 a. m.	57 32 00	150 18 00	59	gy. S. G	56	56	42.6	...do	25
1418	...do	5:17 a. m.	57 39 00	150 33 00	51	S. brk. Sh	54	52	45.1	...do	25
1419	...do	6:43 a. m.	57 44 00	150 46 00	43	S. brk. Sh	55	53	46.8	...do	25
1420	...do	8:00 a. m.	57 51 00	151 00 00	40	S. G	58	53	46.5	...do	25
1421	...do	9:18 a. m.	57 57 00	151 08 00	36	brk. S. G	55	54	46.5	...do	25
1422	...do	10:54 a. m.	58 03 00	151 26 00	78	Fne. gy. S	55	54	44.1	...do	25
1423	...do	1:27 p. m.	58 14 00	151 23 00	41	G	59	56	44.1	...do	25
1424	...do	2:40 p. m.	58 20 00	151 11 00	60	gy. S. G	59	53	43.6	...do	25
1425	...do	4:00 p. m.	58 12 00	151 01 00	56	gy. S. brk. Sh	63	53	44.1	...do	25

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time of day.	Position		Depth.	Character of bottom.	Temperature.			Kind of reel.	Weight of sinker.
			Lat. N.	Long. W.			Air.	Surface.	Bot.		
	1888.		° ′ ″	° ′ ″	Fms.		° F.	° F.	° F.		Lbs.
1426	Aug. 22	8:31 p. m.	57 58 00	150 32 00	102	gy. S.	59	56	41.3	Tanner	25
1427	...do...	9:46 p. m.	57 52 00	150 16 00	114	gy. S. bk. Sp	56	55	41.1	...do...	25
1428	...do...	11:03 p. m.	57 47 00	150 00 00	113	gy. S. bk. Sp	54	55	41.3	...do...	25
1429	Aug. 23	12:22 a. m.	57 41 00	149 44 00	140	gy. S. bk. Sp	55	56	41.1	...do...	25
1430	...do...	1:45 a. m.	57 47 00	149 31 00	119	gy. S. bk. Sp	55	56	41.6	...do...	25
1431	...do...	3:04 a. m.	57 53 00	149 19 00	166	gy. S. bk. Sp	55	56	41.1	...do...	25
1432	...do...	4:24 a. m.	57 59 00	149 33 00	112	gy. S.	54	56	41.5	...do...	25
1433	...do...	5:43 a. m.	58 05 00	149 48 00	128	gy. S	59	55	41.3	...do...	25
1434	...do...	7:01 a. m.	58 11 00	150 03 00	69	gy. S. P.	63	56	44.1	...do...	25
1435	...do...	8:28 a. m.	58 17 00	150 17 00	37	brk. Sh. G	64	56	49.1	...do...	25
1436	...do...	9:43 a. m.	58 23 00	150 32 00	37	brk. Sh	58	53	48.5	...do...	25
1437	...do...	11:17 a. m.	58 29 00	150 48 00	50	S. P. brk. Sh	58	54	44.1	...do...	25
1438	...do...	12:39 p. m.	58 35 00	151 03 00	99	gy. S	57	54	41.1	...do...	25
1439	...do...	1:53 p. m.	58 40 00	151 16 00	99	rky	56	54	41.1	...do...	25
1440	...do...	3:00 p. m.	58 50 00	151 07 00	76	gy. S.	56	54	41.6	...do...	25
1441	...do...	4:18 p. m.	58 57 00	151 00 00	97	gy. M	56	54	41.2	...do...	25
1442	...do...	5:35 p. m.	58 51 00	150 47 00	84	gy. S.	55	56	41.2	...do...	25
1443	...do...	6:54 p. m.	58 46 00	150 33 00	105	brk. Sh. P.	55	55	41.3	...do...	25
1444	...do...	8:13 p. m.	58 40 00	150 17 00	69	gy. S. brk. Sh	55	54	41.1	...do...	25
1445	...do...	9:32 p. m.	58 33 00	150 03 00	67	gy. S. P	55	54	41.1	...do...	25
1446	...do...	10:56 p. m.	58 27 00	149 47 00	84	bk. S.	55	54	40.9	...do...	25
1447	Aug. 24	12:21 a. m.	58 21 00	149 33 00	90	gy. S.	56	56	41.3	...do...	25
1448	...do...	1:41 a. m.	58 14 00	149 17 00	85	gy. S	56	56	41.2	...do...	25
1449	...do...	3:02 a. m.	58 08 00	149 04 00	77	gy. S. P	56	56	41.7	...do...	25
1450	...do...	4:28 a. m.	58 01 00	148 49 00	98	gy. S.	56	56	41.6	...do...	25
1451	...do...	6:21 a. m.	57 54 00	148 34 00	507	bu. M	57	56	38.1	Sigsbee	38
1452	...do...	8:25 a. m.	58 00 00	148 20 00	594	bk. S. G	60	59	37.6	...do...	38
1453	...do...	10:03 a. m.	58 10 00	148 20 00	761	bu. M	62	59	37.0	...do...	38
1454	...do...	1:38 p. m.	58 24 00	148 46 00	71	gy. S	60	59	41.7	Tanner	25
1455	...do...	2:56 p. m.	58 31 00	148 57 00	66	gy. S. G. Sh	58	57	41.8	...do...	25
1456	...do...	4:15 p. m.	58 39 00	149 08 00	72	gy. S.	58	57	42.1	...do...	25
1457	...do...	5:33 p. m.	58 46 00	149 17 00	103	bu. M	57	56	41.6	...do...	25
1458	...do...	6:55 p. m.	58 53 00	149 30 00	122	gy M	57	57	41.6	...do...	25
1459	...do...	9:03 p. m.	58 44 00	149 02 00	118	gy. S.	57	56	.....	...do...	25
1460	...do...	10:23 p. m.	58 37 00	148 45 00	99	gy. S.	57	56	41.8	...do...	25
1461	...do...	11:42 p. m.	58 30 00	148 29 00	106	G. S.	57	57	41.5	...do...	25
1462	Aug. 25	1:31 a. m.	58 23 00	148 07 00	902	bu. M	57	57	36.0	Sigsbee	38
1463	...do...	3:10 a. m.	58 32 00	148 07 00	358	bu. M	57	58	39.1	Tanner	25
1464	...do...	4:30 a. m.	58 41 00	148 07 00	151	gy. S.	57	58	40.9	...do...	25
1465	...do...	5:46 a. m.	58 37 00	147 50 00	301	S. G.	57	58	.....	...do...	25
1466	...do...	7:30 a. m.	58 45 00	147 50 00	537	bu. M	62	59	38.0	Sigsbee	38
1467	...do...	9:06 a. m.	58 54 00	147 50 00	87	Sh	63	57	41.8	...do...	38
1468	...do...	10:21 a. m.	59 02 00	147 50 00	101	M. G.	64	56	41.7	...do...	38
1469	...do...	11:37 a. m.	59 05 00	147 33 00	308	S. R.	62	56	39.2	Tanner	25
1470	...do...	12:54 p. m.	59 10 00	147 17 00	252	rky	61	57	40.1	...do...	25
1471	...do...	2:09 p. m.	39 15 00	147 00 00	109	bu. M	59	53	41.1	...do...	25
1472	...do...	3:23 p. m.	59 20 00	146 42 00	92	bu. M	57	53	42.6	...do...	25
1473	...do...	4:34 p. m.	59 21 00	146 26 00	45	rky	59	53	44.8	...do...	25
1474	...do...	5:11 p. m.	59 24 00	146 19 00	11	rky	58	53	51.8	...do...	25
1475	Aug. 26	8:39 a. m.	59 20 00	146 23 00	15	G. P	61	53	49.8	...do...	25
1476	...do...	3:40 p. m.	59 12 00	146 20 00	22	No specimen	58	53	.....	Hand lead	
1477	...do...	4:26 p. m.	59 09 00	146 13 00	141	P.	58	53	41.2	Tanner	25
1478	...do...	5:39 p. m.	59 03 00	145 56 00	620	bu. M	61	57	37.0	Sigsbee	38
1479	...do...	8:30 p. m.	58 51 00	145 25 00	2,425	M	59	58	35.0	...do...	38
1480	Aug. 27	2:54 a. m.	59 01 00	144 22 00	2,220	gy. oz	59	59	35.0	...do...	60
1481	...do...	7:31 a. m.	59 08 00	143 30 00	2,138	gy. oz	60	59	35.0	...do...	60
1482	...do...	10:39 a. m.	59 12 00	143 00 00	1,528	gy. oz	63	59	35.1	...do...	60
1483	...do...	1:32 p. m.	59 00 00	142 37 00	1,764	gy. oz	65	60	35.0	...do...	60
1484	...do...	3:38 p. m.	58 54 00	142 33 00	1,745	br. and gy. oz	64	60	35.0	...do...	60
1485	...do...	5:33 p. m.	58 56 00	142 18 00	1,675	br. and gy. oz	62	60	35.0	...do...	60
1486	...do...	7:24 p. m.	58 58 00	141 59 00	1,500	gy. oz	60	59	35.0	...do...	60
1487	...do...	9:19 p. m.	58 51 00	141 46 00	1,548	gy. oz	60	60	35.1	...do...	60
1488	Aug. 28	3:51 a. m.	58 17 00	140 35 00	1,815	gy. oz	60	60	35.0	...do...	60
1489	...do...	11:26 a. m.	57 45 00	139 25 00	1,778	br. and gy. oz	56	58	.....	...do...	60
1490	Aug. 29	12:48 a. m.	56 35 00	137 55 00	1,433	No specimen	57	57	.....	...do...	60
1491	Aug. 30	5:56 a. m.	54 02 00	134 34 00	1,571	br. and gy. oz	57	57	35.3	...do...	38
1492	...do...	6:29 p. m.	52 32 00	133 05 00	1,601	gy. oz	67	60	35.1	...do...	38
1493	Aug. 31	4:38 a. m.	51 34 00	131 25 00	1,099	gn. M	59	59	35.9	...do...	38
1494	...do...	6:44 p. m.	51 09 00	129 07 00	83	bu. M	69	60	44.2	Tanner	25
1495	...do...	10:02 p. m.	51 01 00	128 25 00	52	gy. S.	61	55	46.5	...do...	25
1496	Sept. 1	9:23 a. m.	50 56 00	128 09 00	22	No specimen	56	56	.....	Hand lead	
1497	...do...	9:53 a. m.	50 55 00	128 04 30	16	No specimen	56	56	.....	...do...	
1498	Sept. 19	3:53 a. m.	48 20 00	124 58 30	82	rky	54	52	44.2	Tanner	25
1499	...do...	4:34 a. m.	48 18 00	125 05 30	106	bk. S	54	52	44.2	...do...	25
1500	...do...	5:17 a. m.	48 16 00	125 12 30	108	R.	57	52	43.7	...do...	25
1501	...do...	6:02 a. m.	48 14 00	125 19 30	55	yl. S	57	57	.....	...do...	25

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bot.	Kind of reel.	Weight of sinker.
	1888.		° ′ ″	° ′ ″	Fms.		°F.	°F.	°F.		Lbs.
1502	Sept. 19	6:33 a. m.	48 12 00	125 26 30	70	bk. S	57	57	45.7	Tanner	25
1503	do	7:14 a. m.	48 10 00	125 33 30	86	bk. S	59	60	45.2	do	25
1504	do	7:56 a. m.	48 08 00	125 40 30	105	bk. S	59	61	44.8	do	25
1505	do	9:12 a. m.	48 06 00	125 47 30	586	gn. M	59	61	38.2	Sigsbee	38
1506	do	10:18 a. m.	48 04 00	125 54 30	505	gn. M	59	59	38.6	do	38
1507	do	11:18 a. m.	48 03 00	126 01 30	692	gn. M	60	59	38.0	do	38
1508	do	12:25 p. m.	48 01 00	126 09 00	768	br. M	62	60	37.2	do	38
1509	do	1:41 p. m.	47 59 00	126 15 00	856	br. M	62	60	36.7	do	38
1510	do	3:04 p. m.	47 57 00	126 22 30	816	br. M	62	60	36.7	do	38
1511	do	4:25 p. m.	47 55 00	126 29 00	1,239	br. M	61	59		do	38
1512	Sept. 20	12:47 p. m.	48 07 00	125 03 00	80	gn. M	57	58	44.7	Tanner	25
1513	do	7:34 p. m.	48 07 00	125 00 30	178	fne. gy. S	58	58		do	25
1514	do	8:40 p. m.	48 05 00	125 08 00	77	gy. S. and P	58	58	44.7	do	25
1515	do	9:42 p. m.	48 03 00	125 15 00	82	P	59	57	44.7	do	25
1516	do	10:47 p. m.	48 01 00	125 22 00	218	bu. M. and G	59	59	42.7	do	25
1517	Sept. 21	12:04 a. m.	47 59 00	125 29 00	90	S. and G	59	59	44.7	do	25
1518	do	1:20 a. m.	47 58 00	125 35 00	141	S. and G	58	57	43.2	do	25
1519	do	2:24 a. m.	47 56 00	125 42 30	378	gn. M	59	59	39.7	Sigsbee	38
1520	do	3:39 a. m.	47 52 00	125 35 00	274	G	59	58	40.2	Tanner	25
1521	do	4:57 a. m.	47 49 00	125 28 00	462	yl. oz	58	58	39.7	Sigsbee	38
1522	do	5:57 a. m.	47 46 00	125 20 30	522	yl. oz	58	58	39.1	do	38
1523	do	6:55 a. m.	47 47 00	125 14 00	378	yl. oz	60	58	40.1	do	38
1524	do	7:44 a. m.	47 48 00	125 07 00	206	gy. oz	60	58	42.9	Tanner	38
1525	do	8:33 a. m.	47 49 00	124 59 00	67	No specimen	60	58	45.1	do	38
1526	do	9:13 a. m.	47 51 00	124 52 00	52	gy. S. and P	63	58	46.5	do	38
1527	do	2:41 p. m.	47 48 00	124 43 00	30	gy. S	61	58	48.1	do	38
1528	do	3:22 p. m.	47 43 00	124 41 00	33	fne. Gy. S	61	59	48.1	do	38
1529	do	5:25 p. m.	47 36 00	124 46 00	53	bk. S	63	58	49.1	do	38
1530	do	6:10 p. m.	47 35 00	124 53 00	75	fne. gy. S	63	58	45.7	do	38
1531	do	6:55 p. m.	47 33 00	125 01 00	111	fne. bk. S	63	58	44.9	do	38
1532	do	7:44 p. m.	47 32 00	125 08 00	287	bu. M	63	58	41.1	Sigsbee	38
1533	do	8:38 p. m.	47 27 00	125 06 00	535	bu. M	60	59	39.2	do	38
1534	do	9:36 p. m.	47 22 00	125 03 30	758	gy. oz	60	59	37.1	do	38
1535	do	10:34 p. m.	47 17 00	125 01 30	578	gy. oz	59	59	38.3	do	38
1536	do	11:32 p. m.	47 18 00	124 54 00	386	No specimen	58	58	40.1	do	38
1537	Sept. 22	12:23 a. m.	47 19 00	124 47 00	82	bu. M	58	58	44.9	Tanner	25
1538	do	1:04 a. m.	47 21 00	124 39 30	51	fne. bk. S	57	57	45.9	do	25
1539	do	1:45 a. m.	47 22 00	124 32 00	28	G. and P	57	57	46.9	do	25
1540	do	2:26 a. m.	47 17 00	124 30 00	28	gy. S	57	57	47.6	do	25
1541	do	3:04 a. m.	47 12 00	124 28 00	28	P	57	57	46.9	do	25
1542	do	3:43 a. m.	47 07 00	124 26 00	28	gy. S	56	57	48.1	do	25
1543	do	4:26 a. m.	47 05 00	124 32 30	41	bk. S	56	57	46.6	do	25
1544	do	5:07 a. m.	47 04 00	124 39 30	56	bk. S	56	57	46 0	do	25
1545	do	5:45 a. m.	47 02 00	124 47 00	74	bk. S. P	56	57	45.9	do	25
1546	do	6:25 a. m.	47 00 00	124 53 30	93	gn. M	54	56	44.9	do	25
1547	do	7:07 a. m.	46 58 00	125 00 30	438	gn. M	54	56	39.7	do	25
1548	do	8:03 a. m.	46 53 00	124 57 00	450	gn. M	56	58	39.4	do	25
1549	do	8:48 a. m.	46 54 00	124 50 00	91	No specimen	56	58		do	25
1550	do	9:41 a. m.	46 56 00	124 43 00	78	G. S	57	59		do	25
1551	do	10:21 a. m.	46 51 00	124 41 00	76	G. M	57	59	46.0	do	25
1552	do	11:01 a. m.	46 50 00	124 48 00	87	rky	57	60	46.0	do	25
1553	do	11:41 a. m.	46 48 00	124 55 00	250	rky	57	59		do	25
1554	do	12:38 p. m.	46 43 00	124 52 00	181	rky	58	60	44.9	do	25
1555	do	1:23 p. m.	46 45 00	124 44 00	80	gy. S	58	60	46.0	do	25
1556	do	2:00 p. m.	46 47 00	124 37 00	64	rky	60	60	46.1	do	25
1557	do	2:41 p. m.	46 49 00	124 30 00	42	rky	60	59	47.0	do	25
1558	do	3:18 p. m.	46 51 00	124 22 30	33	gy. and bk. S	60	59	48.1	do	25
1559	do	3:56 p. m.	46 54 00	124 15 00	18	gy. S	60	59	57.8	do	25
1560	do	4:47 p. m.	46 54 00	124 22 30	35	fne. gy. S	57	59	48.3	do	25
1561	do	5:32 p. m.	46 54 00	124 30 00	48	fne. gy. S	58	59	47.0	do	25
1562	do	6:10 p. m.	46 51 00	124 35 00	58	fne. gy. S	57	59	46.4	do	25
1563	do	6:52 p. m.	46 55 00	124 39 00	64	fne. gy. S	57	59	55.8	do	25
1564	do	7:25 p. m.	46 52 00	124 45 00	78	fne. bk. S	57	53	46.0	do	25
1565	do	8:18 p. m.	46 47 00	124 43 00	81	gy. S	58	60	45.5	do	25
1566	do	9:33 p. m.	46 36 00	124 39 00	132	rky	58	60	45.0	do	25
1567	do	10:28 p. m.	46 53 00	124 32 00	72	gy. m	58	60	45.4	do	25
1568	do	11:24 p. m.	46 40 00	124 25 00	50	gy. S	58	59	46	do	25
1569	Sept. 23	12:15 a. m.	46 41 00	124 18 00	37	gy. S	57	58	46.7	do	25
1570	do	1:11 a. m.	46 37 00	124 17 30	37	hrd. S	57	58	46.1	do	25
1571	do	1:58 a. m.	46 35 00	124 24 30	51	hrd. S	58	58		do	25
1572	do	2:37 a. m.	46 33 00	124 31 00	82	hrd. S	58	58	45.1	do	25
1573	do	3:36 a. m.	46 31 00	124 38 00	433	No. specimen	58	58	39.2	do	25
1574	Sept. 25	9:43 a. m.	48 34 00	124 53 00	65	gn. M	55	51	45.8	do	25
1575	Sept. 29	10:22 a. m.	48 27 00	125 09 00	60	S. R	54	53	45.2	do	25
1576	Oct. 10	3:51 p. m.	48 16 00	123 40 00	101	S. G	52	49	45.2	do	25
1577	Oct. 11	3:36 p. m.	46 34 00	124 12 30	20	gy. S	60	57	52.9	do	25

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bot.	Kind of reel.	Weight of sinker.
	1888.		° ′ ″	° ′ ″	Fms.		°F.	°F.	°F.		Lbs.
1578	Oct. 11	4:36 p. m.	46 33 00	124 19 00	38	fne. gy. S	61	58	47	Tanner	25
1579	...do...	5:17 p. m.	46 32 00	124 26 00	51	fne. gy. S	61	58	47	...do....	25
1580	...do...	5:58 p. m.	46 31 00	124 33 00	153	gr. M	61	58	45	...do....	25
1581	...do...	6:42 p. m.	46 30 00	124 39 30	432	br. oz	61	58	39.6	Sigsbee	38
1582	...do...	7:38 p. m.	46 28 00	124 33 00	98	fne. gy. S	61	58	44.8	Tanner	25
1583	...do...	8:22 p. m.	46 27 00	124 26 00	55	bk. S	61	58	47	...do....	25
1584	...do...	9:10 p. m.	46 25 00	124 20 00	40	bu. M	60	58	47.9	...do....	25
1585	...do...	9:59 p. m.	46 23 00	124 27 00	59	fne. br. S	60	58	47	...do....	25
1586	...do...	10:52 p. m.	46 22 00	124 34 00	78	fne. gy. S	58	59	46.5	...do....	25
1587	...do...	11:49 p. m.	46 21 00	124 41 00	260	bu. M	58	59	42.5	...do....	25
1588	Oct. 13	6:58 a. m.	46 03 00	124 22 00	73	fne. gy. S	57	57	45.1	...do....	25
1589	...do...	7:48 a. m.	46 02 00	124 29 00	82	fne. gy. S	57	57	45.8	...do....	25
1590	...do...	8:38 a. m.	46 00 00	124 36 00	96	br. S	58	56	46.0	...do....	25
1591	...do...	9:26 a. m.	45 58 00	124 42 30	199	gy. oz	58	56	43.8	...do....	25
1592	...do...	10:18 a. m.	46 03 00	124 45 00	174	gy. oz	60	61	44.2	...do....	25
1593	...do...	11:35 a. m.	46 07 00	124 48 00	601	br. oz	62	62	38.8	...do....	25
1594	...do...	12:30 p. m.	46 08 00	124 39 00	102	bk. S	64	60	45.9	...do....	25
1595	...do...	1:15 p. m.	46 08 00	124 31 00	78	fne. gy. S	64	60	46.1	...do....	25
1596	...do...	4:46 p. m.	46 17 00	124 21 30	81	bu. M	62	60	46.6	...do....	25
1597	...do...	5:35 p. m.	46 16 00	124 28 30	231	bu. M	58	57	43.1	...do....	25
1598	...do...	6:36 p. m.	46 15 00	124 36 00	421	br. oz	57	57	39.8	Sigsbee	38
1599	...do...	7:46 p. m.	46 14 00	124 42 30	475	gy. oz	57	56	39.6	...do....	38
1600	...do...	9:01 p. m.	46 13 00	124 50 00	506	br. oz	56	56	39.3	...do....	38
1601	Oct. 19	6:40 a. m.	44 04 00	124 53 00	56	M	57	57	47.1	Tanner	25
1602	...do...	7:06 a. m.	44 02 00	124 55 00	51	crs. bk. S	57	57	47.6	...do....	25
1603	...do...	11:52 a. m.	43 59 00	125 02 00	91	bk. S. G	60	58	46.2	...do....	25
1604	...do...	12:20 p. m.	43 59 00	125 05 00	563	gy. M	60	58	38.7	Sigsbee	38
1605	...do...	1:14 p. m.	43 54 00	125 05 00	355	bk. S	60	59	40.3	...do....	38
1606	...do...	2:04 p. m.	43 50 00	125 01 30	299	gy. C	60	59	42.1	...do....	38
	1889.										
1607	Jan. 5	4:05 p. m.	34 00 00	120 30 00	226	gy. S	64	59	46.3	...do....	38
1608	Jan. 8	8:55 a. m.	34 25 30	120 20 30	21	gy. S. M. brk Sh	.....	.....	.....	Tanner	25
1609	Jan. 15	4:34 p. m.	32 36 30	117 20 30	97	yl. M	57	59	53	Sigsbee	38
1610	...do...	5:25 p. m.	32 36 00	117 26 00	324	yl. M	57	59	43	...do....	38
1611	...do...	6:20 p. m.	32 35 30	117 32 00	660	br. Oz	56	59	38.7	...do....	38
1612	...do...	8:10 p. m.	32 34 30	117 43 30	266	rky	56	59	44.5	...do....	38
1613	...do...	9:55 p. m.	32 33 30	117 55 00	211	rky	55	58	46	...do....	38
1614	...do...	11:32 p. m.	32 32 00	118 07 00	1047	gy. M	57	58	37	...do....	38
1615	Jan. 16	1:27 a. m.	32 31 00	118 18 30	770	fne. S. bk. Sp	55	59	37.8	...do....	38
1616	...do...	3:26 a. m.	32 30 00	118 30 30	615	fne. S. G	55	59	37.5	...do....	38
1617	...do...	5:32 a. m.	32 29 00	118 42 00	324	R	55	59	.....	...do....	38
1618	...do...	6:32 a. m.	32 28 30	118 48 00	741	gn. Oz	55	59	38.6	...do....	38
1619	...do...	7:39 a. m.	32 28 00	118 53 30	692	gn. Oz	55	59	43.2	...do....	38
1620	...do...	8:51 a. m.	32 27 30	118 59 00	389	gy. S. brk. Sh	55	59	42.2	...do....	38
1621	...do...	10:52 a. m.	32 25 30	119 05 00	17	rky	56	59	59.5	Tanner	25
1622a	...do...	11:10 a. m.	32 25 15	119 04 30	6	rky	56	59	.....	Hand lead	
1622	...do...	5:40 p. m.	32 20 00	119 04 30	337	S. G	56	59	43	Tanner	25
1623	...do...	6:48 p. m.	32 15 00	119 06 30	713	gy. M	56	59	38	Sigsbee	38
1624	...do...	8:41 p. m.	32 20 00	119 08 30	449	rky	57	59	40.8	...do....	38
1625	...do...	9:48 p. m.	32 22 30	119 09 30	186	gy. S	57	59	46.3	...do....	88
1626	...do...	10:30 p. m.	32 24 30	119 10 30	77	gy. S	57	58	51.1	...do....	38
1627	...do...	11:08 p. m.	32 23 00	119 12 00	176	gy. S	57	58	46.6	...do....	38
1628	...do...	11:57 p. m.	32 21 00	119 15 00	386	gy. S	57	58	42.2	...do....	38
1629	Jan. 17	1:04 a. m.	32 17 30	119 19 00	295	rky	56	59	44.7	Sigsbee	88
1630	...do...	9:26 a. m.	32 27 30	119 15 30	156	gy. S	57	58	48.7	...do....	38
1631	...do...	9:50 a. m.	32 29 30	119 14 30	47	bk. S. G	57	58	54.3	...do....	38
1632	...do...	10:39 a. m.	32 29 45	119 13 00	26	bk. S. G	57	59	58.6	Tanner	25
1633	...do...	11:27 a. m.	32 29 00	119 14 00	43	bk. S. G	59	59	.....	...do....	25
1634	...do...	2:03 p. m.	32 27 30	119 12 30	46	gy. S	59	60	54.1	...do....	25
1635	...do...	2:14 p. m.	32 28 00	119 11 30	44	rky	59	60	55.4	...do....	25
1636	...do...	2:24 p. m.	32 28 30	119 11 00	45	gy. S. bk. Sp. C	64	59	54.9	...do....	25
1637	...do...	2:59 p. m.	32 27 00	119 11 00	48	Co. brk Sh	64	59	54.7	...do....	22
1638	...do...	3:12 p. m.	32 26 45	119 09 30	47	bk. S. brk. Sh	64	59	55.3	...do....	25
1639	...do...	3:21 p. m.	32 26 30	119 08 30	30	gy. S. brk. Sh	64	60	59.4	...do....	25
1640	...do...	4:16 p. m.	32 26 30	119 07 30	11	rky	60	59	.....	Hand lead	
1641	...do...	5:29 p. m.	32 28 00	119 05 30	51	R. gy. S. brk. Sh	60	59	54.5	Tanner	25
1642	...do...	6:05 p. m.	32 30 00	119 06 15	113	gy. S. G	57	58	49.1	...do....	25
1643	...do...	6:30 p. m.	32 32 00	119 07 00	174	R	57	58	46.9	...do....	38
1644	...do...	7:03 p. m.	32 34 15	119 08 00	153	gy. S	57	58	47.4	Sigsbee	38
1645	...do...	7:50 p. m.	32 39 00	119 10 00	106	brk. Sh. G	55	57	50.1	...do....	38
1646	...do...	8:45 p. m.	32 45 00	119 11 30	59	gy. S	55	57	53.4	...do....	38
1647	...do...	9:17 p. m.	32 47 45	119 12 30	243	gy. S	56	58	55.4	...do....	38
1648	...do...	10:17 p. m.	32 53 00	119 12 30	495	br. M	56	58	40.3	...do....	38
1649	...do...	11:25 p. m.	32 59 00	119 14 00	614	br. M	56	58	39.4	...do....	38
1650	Jan. 18	12:31 a. m.	33 05 00	119 15 00	892	M	56	58	39	...do....	38
1651	...do...	1:55 a. m.	33 10 00	119 21 00	310	M	55	58	43.5	Tanner	25
1652	...do...	2:26 a. m.	33 12 00	119 23 00	47	fne. gy. S	55	58	54.1	...do....	25
1653	...do...	2:31 p. m.	33 11 00	119 19 15	464	br. S. G	59	59	40.8	Sigsbee	38

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bot.	Kind of reel.	Weight of sinker.
	1889.		° ′ ″	° ′ ″	Fms.		°F.	°F.	°F.		Lbs.
1654	Jan. 18	3:24 p. m.	33 09 30	119 12 30	950	gn. Oz	64	61	39	Sigsbee	38
1655	...do...	5:05 p. m.	33 06 30	118 58 30	924	M	67	61	39	...do	38
1656	...do...	6:39 p. m.	33 03 15	118 45 30	766	gy. S	59	59	39.2	...do	38
1657	...do...	8:15 p. m.	33 08 00	118 34 30	485	M	58	59	40.7	...do	38
1658	...do...	9:42 p. m.	33 08 30	118 22 30	560	M	57	59	40	...do	38
1659	do...	11:15 p. m.	33 03 00	118 12 30	552	M	56	58	39.8	...do	38
1660	Jan. 19	12:45 a. m.	32 57 00	118 02 30	426	gy. Oz	56	58	40.7	...do	38
1661	...do...	2:17 a. m.	32 52 00	117 52 00	360	gy. Oz	56	59	51.9	...do	38
1662	...do...	3:42 a. m.	32 46 00	117 41 30	428	gn. M	55	59	41.4	...do	38
1663	Jan. 23	1:28 p. m.	32 46 30	118 00 30	395	R	58	59	41.6	...do	38
1664	Jan. 24	5:08 a. m	32 47 30	118 29 30	219	R	58	58	46.9	...do	38
1665	...do...	6:03 a. m.	32 47 00	118 37 00	657	gy. M	59	59	39	...do	38
1666	...do...	7:13 a. m.	32 46 15	118 44 00	613	R. crs. gy. S	59	59	39	...do	38
1667	...do...	8:17 a. m.	32 44 00	118 53 00	807	gn. M	59	59	39	...do	38
1668	...do...	9:27 a. m.	32 44 00	119 00 00	569	gn. M	58	59	39.5	...do	38
1669	...do...	10:30 a. m.	32 43 45	119 06 45	241	yl. S	58	59	45.1	...do	38
1670	...do...	10:54 a. m.	32 43 45	119 09 15	56	gy. S. brk. Sh	58	59	56.1	Tanner	25
1671	...do...	11:14 a. m.	32 43 45	119 11 30	43	brk. Sh. G	59	60	56.1	...do	25
1672	...do...	11:44 a. m.	32 43 45	119 14 00	46	R. Sh	59	60	55.3	...do	25
1673	...do...	12:03 p. m.	32 43 45	119 16 30	108	G. brk. Sh	59	60	...	...do	25
1674	...do...	12:28 p. m.	32 45 45	119 15 15	83	yl. S. G	59	60	52.8	...do	25
1675	...do...	12:45 p. m.	32 45 45	119 12 30	71	gy. S. brk. Sh	59	60	52.8	...do	25
1676	...do...	1:04 p. m	32 46 00	119 10 00	173	gy. S	64	61	52.8	...do	25
1677	...do...	1:22 p. m.	32 46 00	119 07 30	340	br. M	64	61	.	...do	25
1678	...do...	2:07 p. m.	32 42 30	119 05 15	53	gy. S	66	61	54.9	...do	25
1679	...do...	2:31 p. m.	32 42 45	119 07 15	28	R	66	61	56.9	...do	25
1680	...do...	3:13 p. m.	32 42 45	119 09 30	48	R. brk. Sh	64	61	...	...do	25
1681	...do...	3:30 p. m.	32 43 00	119 11 30	62	G. gy. S. brk. Sh	64	61	55	...do	25
1682	...do...	3:48 p. m.	32 43 00	119 14 00	229	R	64	61	55	...do	25
1683	...do...	4:11 p. m.	32 41 00	119 12 45	153	R	63	61	47.4	...do	18
1684	...do...	4:30 p. m.	32 41 00	119 10 45	118	gy. S	63	61	47.4	...do	18
1685	...do...	4:49 p. m.	32 41 15	119 08 45	52	S. brk. Sh	63	61	47.4	...do	18
1686	...do...	5:06 p. m.	32 41 15	119 06 15	55	gy. S. brk. Sh	71	61	47.5	...do	18
1687	...do...	5:24 p. m.	32 41 30	119 04 00	126	gy. S	71	62	47.4	...do	18
1688	...do...	5:46 p. m.	32 39 45	119 05 15	98	gy. S	71	62	47.4	...do	25
1689	...do...	6:06 p. m.	32 39 30	119 07 45	159	R	61	59	47.4	...do	25
1690	...do...	6:26 p. m.	32 39 15	119 10 00	110	gy. S	61	59	47.3	...do	25
1691	...do...	6:45 p. m.	32 39 00	119 12 15	125	gy. S	61	59	47.2	...do	25
1692	...do...	7:08 p. m.	32 36 30	119 12 15	107	gy. S. G	58	59	49	...do	25
1693	...do...	7:26 p. m.	32 34 15	119 12 00	88	gy. S. brk. Sh	58	59	50.5	...do	25
1694	...do...	7:44 p. m.	32 32 00	119 12 00	62	gy. S	58	59	53	...do	25
1695	...do...	8:01 p. m.	32 30 15	119 13 30	31	brk. Sh	58	59	.....	...do	25
1696	...do...	8:20 p. m.	32 29 45	119 11 30	47	brk. Sh	58	59	53.1	...do	25
1697	...do...	8:39 p. m.	32 31 00	119 09 30	55	crs. wh. and bk. S. brk. Sh.	58	59	53.1	...do	25
1698	...do...	8:58 p. m.	32 32 15	119 07 45	63	crs. bk. S. brk. Sh.	58	59	53.6	...do	25
1699	...do...	9:17 p. m.	32 33 30	119 06 00	214	Sh	58	58	45.6	...do	25
1700	...do...	9:40 p. m.	32 34 45	119 04 00	367	hrd. m	58	58	45.4	...do	25
1701	...do...	10:08 p. m.	32 32 30	119 03 15	406	gy. S. brk. Sh	59	58	41.8	...do	25
1702	...do...	10:38 p. m.	32 30 30	119 02 30	286	gy. S	59	58	41.6	...do	25
1703	...do...	11:03 p. m.	32 28 30	119 01 45	141	gy. S	59	58	41.8	...do	25
1704	...do...	11:21 p. m.	32 26 30	119 01 15	60	gy. S	59	58	...	...do	25
1705	Jan. 26	8:32 a. m.	32 24 45	117 21 00	533	br. M	60	59	39.7	Sigsbee	38
1706	...do...	9:37 a. m.	32 25 00	117 18 00	51	hrd. M	59	59	.	Tanner	25
1707	Feb. 4	10:14 a. m.	32 40 [illegible]	117 19 00	45	M	58	59	56	Sigsbee	38
1708	...do...	2:16 p. m.	32 55 30	117 34 00	441	gn. M	60	61	40.8	...do	38
1709	...do...	3:05 p. m.	33 00 00	117 37 30	454	gn. M	61	61	40.5	...do	38
1710	...do...	6:13 p. m.	33 08 00	117 45 00	452	gy. M	62	60	46.4	...do	38
1711	...do...	7:05 p. m.	33 11 30	117 47 30	445	gy. M	61	60	40.8	...do	38
1712	...do...	8:00 p. m.	33 15 00	117 51 00	432	gn. M	61	60	41	...do	38
1713	...do...	8:56 p. m.	33 18 45	117 53 45	327	R. bk. S	61	60	43.2	...do	38
1714	...do...	9:47 p. m.	33 22 30	117 56 00	324	gn. M	60	59	43.2	...do	38
1715	...do...	10:38 p. m.	33 26 00	117 59 00	276	gn. M	60	60	51	...do	38
1716	...do...	11:30 p. m.	33 29 30	118 02 30	264	gn. M	60	60	45	...do	38
1717	Feb. 5	12:23 a. m.	33 33 30	118 05 00	161	gn. M	58	59	...	Tanner	25
1718	...do...	1:21 a. m.	33 38 30	118 06 00	21	hrd. M	58	59	59	...do	25
1719	...do...	....	33 41 00	118 16 30	18	fne. gy. S	54	57	....	Hand-lead	
1720	...do...	....	33 40 00	118 16 00	21	fne. gy. S	54	57	...	Tanner	25
1721	...do...	11:34 a. m.	33 39 00	118 15 00	26	fne. gy. S	54	57	57	do	25
1722	...do...	11:51 a. m.	33 37 00	118 13 45	29	fne. gy. S	56	58	58	do	25
1723	...do...	12:01 p. m.	33 36 15	118 13 00	29	fne. gy. S	56	58	58	...do	25
1724	...do...	12:16 p. m.	33 34 30	118 12 00	49	fne. gy. S	56	58	56	...do	25
1725	...do...	12:30 p. m.	33 32 45	118 10 45	115	fne. gy. S	56	58	49.5	...do	25
1726	Feb. 6	11:17 p. m.	34 06 00	119 32 00	124	gn. M	57	60	....	...do	25
1727	...do...	11:27 p. m.	34 05 00	119 31 30	88	gn. M	57	58	....	...do	25
1728	...do...	11:38 p. m.	34 04 00	119 31 30	47	gy. S. bk. sp	57	58	55.5	...do	25

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bot.	Kind of reel.	Weight of sinker.
	1889.		° ′ ″	° ′ ″	*Fms.*		°F.	°F.	°F.		*Lbs.*
1729	Feb. 6	11:55 a. m.	34 03 00	119 29 15	48	gy. S. bk. Sp..	57	58	55	Tanner ..	25
1730	...do ...	12:01 p. m.	34 03 30	119 28 45	48	gy. S. bk Sp...	57	58	55.2	...do	25
1731	...do ..	12:07 p. m.	34 03 45	119 28 15	50	gy. S. bk. Sp. brk. sh.	57	58	56	.. do	25
1732	.. do ...	12:13 p. m.	34 04 00	119 28 00	62	fne. gy. S. G ..	57	58	54	...do	25
1733	...do ...	12:20 p. m.	34 04 30	119 27 00	91	fne. gy. S......	57	58	51.5	.. do	25
1734	.. do ...	12:34 p. m.	34 03 30	119 27 00	49	gy. S	57	58	55.8	...do	25
1735	...do ..	12:45 p. m.	34 02 30	119 27 45	48	gy. S. brk. Sh..	57	58	56	.. do	25
1736	...do ..	12:53 p. m.	34 01 45	119 28 00	42	wh.S.G.brk.sh.	57	58	55.5	...do	25
1737	Feb. 8	10:21 a. m	33 44 30	119 59 00	70	P	58	57	....	...do	25
1738	...do ...	1:20 p. m.	33 48 00	120 10 30	261	R......	57	59	44.4	...do	25
1739	... do ..	2:09 p. m.	33 52 30	120 14 30	194	gy S	58	58	46.7	...do	25
1740	...do ..	2:43 p. m.	33 55 00	120 16 30	124	fne. gy. S. R...	58	58	48.8	...do	25
1741	...do ...	3:55 p. m.	34 00 00	120 20 00	30	fne. gy. S......	58	58	56	.. do	25
1742	Feb. 9	7:58 a. m.	34 06 15	120 29 15	44	R	59	57	...	...do	25
1743	...do ...	8:56 a. m.	34 07 00	120 26 00	41	gy. S...... ...	66	57	54.9	...do	25
1744	.. do ..	9:15 a. m.	34 07 00	120 25 00	36	R	66	57	55	...do	25
1745	.. do ...	9:39 a. m.	34 07 00	120 23 45	42	G brk. Sh. ..	65	57	53 9	...do	25
1746	.. do ...	10:02 a. m.	34 06 30	120 23 30	40	gy. S...... .	66	57	54.4	...do	25
1747	.. do ...	10:18 a. m.	34 06 00	120 23 00	34	brk. Sh. R. .	66	57	54.4	...do	25
1748	Feb. 11	7:49 a. m.	34 23 15	119 40 30	13	Co. sponge ...	62	59	....	Hand lead	
1749	...do ...	8:35 a. m.	34 22 45	119 40 00	22	M	62	59	....	...do	
1750	...do ...	9:05 a. m.	34 23 15	119 39 45	13½	R	62	60	....	...do	
1751	...do ...	....	34 23 40	119 39 50	13	M	62	60	...	...do	
1752	...do ...	10:12 a. m.	34 21 10	119 38 40	26	M	62	60	59	Tanner ..	25
1753	...do ...	10:53 a. m.	34 21 00	119 37 45	26	gy. S. R	66	61	59	.. do	25
1754	.. do ...	2:46 p. m	34 18 45	119 42 00	68	gn M	63	60	53.5	...do	25
1755	.. do ..	4:18 p. m.	34 20 30	119 44 45	50	gn. M. R.......	63	60	54.8	...do	25
1756	Feb. 12	11:13 a. m.	33 59 45	119 21 30	52	gy. S	70	60	....	...do	25
1757	...do ...	11:32 a. m.	34 00 00	119 21 30	36	co. S. brk. Sh..	70	60	....	...do	25
1758	..do ...	6:09 p. m.	33 42 45	119 24 30	825	gn. M	67	61	40.5	...do	25
1759	...do ...	7:15 p. m.	33 37 30	119 25 00	917	gn. M...... ...	64	61	40	Sigsbee .	35
1760	...do ...	8:21 p. m.	33 30 30	119 25 30	899	gn. M..........	64	61	39.8	...do	35
1761	...do ...	9:22 p. m.	33 24 00	119 26 30	416	bk S....... ...	62	60	41	...do	38
1762	...do ...	10:06 p. m.	33 19 30	119 27 00	40	brk. Sh	62	60	57	Tanner ..	28
1763	Feb. 13	6:39 a. m.	33 17 30	119 24 30	42	G.brk.Sh.R.. .	61	58	55.5	...do	28
1764	...do ...	7:23 a. m.	33 17 45	119 28 30	32	gy S...........	61	58	.....	...do	25
1765	...do ...	8:25 a. m.	33 14 15	119 23 30	21	G	60	58	.....	...do	25
1766	...do ..	8:45 a. m.	33 14 00	119 24 00	22½	no specimen.	60	57	.....	...do	25
1767	...do ...	9:49 a. m.	33 16 15	119 20 00	71	Co	60	57	51.4	Sigsbee ..	35
1768	...do ...	10:35 a. m.	33 20 00	119 14 30	644	gy S	62	58	39.5	.. do	35
1769	Feb. 14	6:30 a. m.	33 28 15	118 58 00	185	fne bk.& wh. S.	55	56	46	...do	38
1770	...do ...	7:20 a. m.	33 27 30	118 51 00	718	gn. M	55	56	39.4	...do	38
1771	.. do ..	8:21 a. m.	33 26 15	118 43 15	551	gn. M	56	57	40	...do	38
1772	Feb. 26	4:03 p. m.	32 22 30	117 18 00	76	gy. S. G	61	60	52.8	.. do	38
1773	...do ...	4:43 p. m.	32 17 30	117 19 30	735	gn M	61	60	38	...do	38
1774	...do ...	6:15 p. m.	32 05 45	117 23 15	773	gy. M....... ...	63	59	37.8	...do	38
1775	...do ...	8:30 p. m.	31 50 00	117 27 30	801	gy. Oz	61	59	37.5	.. do	38
1776	...do ...	11:18 p. m.	31 29 30	117 33 00	803	gy. Oz	60	59	37.5	...do	38
1777	Feb. 27	2:36 a. m.	31 03 30	117 40 15	856	gy. M	60	60	37.5	...do	38
1778	...do ..	7:39 a. m.	30 21 00	117 51 30	1,512	choc. Oz	61	60	35.3	...do	38
1779	...do ...	11:08 a. m.	29 56 30	117 58 00	1776	br. M	60	60	35	...do	38
1780	...do ...	1:41 p. m.	29 38 00	118 06 15	1,857	br. M	62	62	35.2	...do	38
1781	.. do ...	5:14 p. m.	29 14 30	118 17 00	1,424	gy. M. S	64	62	35.4	...do	38
1782	..do ...	6:50 p. m.	29 08 30	118 13 30	1,447	gy S	63	61	35.5	.. do	38
1783	Feb. 28	7:05 a. m.	28 56 15	118 18 00	29	gy. S. brk. Sh .	61	61	.....	Tanner ..	25
1784	... do ...	7:41 a. m.	28 57 00	118 16 00	42	G. Sh	61	61	59	.. do	25
1785	...do ...	....	28 57 20	118 17 00	19½	gy. S.....	61	61	...	Hand lead	
1786	.. do ...	6:07 p. m.	28 48 00	118 17 00	1,121	gy. M. S	61	61	36	Sigsbee ..	35
1787	...do ...	8:52 p. m.	28 31 00	118 05 00	1,737	gy. M	61	61	35	...do	60
1788	Mar. 1	5:10 a. m.	27 46 30	117 36 00	2,135	....	60	62	....	...do	35
1789	...do ...	12:16 p. m.	26 58 00	117 04 00	2,065	br. Oz	65	63	34.8	...do	60
1790	...do ...	6:48 p. m	26 12 00	116 37 00	2,124	br. Oz....	75	65	34.9	...do	60
1791	Mar. 2	2:19 a. m.	25 29 00	116 09 00	2,165	br M	65	64	35	...do	60
1792	...do ...	5:54 a. m.	25 15 00	116 00 00	2,131	br. Oz	64	64	34.9	...do	60
1793	...do ...	8:13 a. m.	25 05 00	115 50 00	1,343	br. M. S	66	64	35.4	. do	60
1794	...do ...	11:09 a. m.	24 58 05	115 51 45	55	G. Coralline ...	64	65	64.4	Tanner ..	25
1795	.. do ...	11:29 a. m.	24 54 00	115 43 00	493	R. bk. S..	64	65	40.5	Sigsbee ..	38
1796	...do ...	12:01 p. m.	24 51 00	115 43 00	1,312	br M. S..	65	65	35.4	. do	35
1797	. do ...	2:12 p. m.	24 35 00	115 41 00	2,131	No specimen.	67	66	34.9	..do	60
1798	. do ..	8:39 p. m.	23 46 00	115 34 00	2,119	br. M	66	65	35	.. do	60
1799	Mar. 3	3:10 a. m.	22 57 00	115 25 00	2,167	br. oz	67	66	34.9	.. do	60
1800	.. do ...	9:36 a. m.	22 07 30	115 13 00	2,280	br. M	67	68	35	...do	60
1801	...do ...	4:03 p. m.	21 17 30	115 04 00	1,845	br. M	72	71	35	...do	60
1802	...do ...	10:28 p. m.	20 26 00	114 58 30	2,072	br. Oz	68	69	35	...do	60
1803	Mar. 4	5:05 a. m.	19 35 00	114 52 00	2,032	br. M	67	69	34.9	...do	60
1804	...do ...	11:28 a. m.	18 44 00	114 45 00	1,925	fne. bk. S	70	70	35	...do	60

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bot.	Kind of reel.	Weight of sinker.
	1889.		° ′ ″	° ′ ″	*Fms.*		° F.	° F.	° F.		*Lbs.*
1805	Mar. 4	1:24 p. m.	18 33 30	114 44 00	1,732	gy. S. G	72	71	35	Sigsbee	35
1806	...do ...	2:45 p. m.	18 25 30	114 41 00	281	bk. S	71	71	46.4	...do	35
1807	Mar. 6	6:32 p. m.	18 23 00	114 36 00	651	bk.& Co.S.Glob.	71	70	39.8	...do	35
1808	...do ...	8:44 p. m.	18 23 00	114 18 15	1,987	br. M	71	74	35.3	...do	60
1809	Mar. 7	1:00 a. m.	18 23 30	113 48 00	2,008	br. M	70	72	35.1	...do	60
1810	...do ...	5:23 a. m.	18 24 30	113 15 00	2,012	br. M	69	72	36.7	...do	60
1811	...do ...	9:41 a. m.	18 25 00	112 44 00	1,951	br. M	71	73	35.3	...do	60
1812	...do ...	1:44 p. m.	18 28 30	112 12 00	1,854	br. M	75	74	35.4	...do	60
1813	...do ...	5:52 p. m.	18 32 00	111 41 00	1,829	br. M	70	72	......	...do	60
1814	...do ...	8:50 p. m.	18 35 00	111 21 00	1,786	br. M	70	71	35.3	...do	60
1815	...do ...	10:35 p. m.	18 38 00	111 11 00	1,823	R	70	70	35.3	...do	60
1816	...do ...	11:54 p. m.	18 39 00	111 07 00	1,619	rky	69	70	35.5	...do	60
1817	Mar. 8	5:51 a. m.	18 39 45	111 02 00	1,161	rky	70	70	36.2	...do	35
1818	...do ...	6:47 a. m.	18 40 45	110 58 30	651	rky	70	70	39.4	...do	35
1819	Mar. 10	4:49 a. m.	18 53 00	110 51 00	1,264	br. M. bk. S	70	70	35.8	...do	35
1820	...do ...	6:35 a. m.	19 03 00	110 50 30	1,635	br. M	71	70	35.6	...do	60
1821	...do ...	8:21 a. m.	19 12 00	110 50 00	910	br. M	71	72	37.5	...do	35
1822	...do ...	9:18 a. m.	19 15 30	110 49 15	210	rky	71	73	50.3	...do	38
1823	...do ...	3:05 p. m.	19 21 30	110 47 00	375	bk. S	73	73	44	...do	35
1824	...do ...	3:55 p. m.	19 26 15	110 45 30	665	R	72	73	39.2	...do	35
1825	...do ...	5:57 p. m.	19 40 15	110 41 15	1,807	br. M	72	73	35.5	...do	35
1826	...do ...	10:11 p. m.	20 09 00	110 32 30	1,643	br. M	70	70	35.5	...do	35
1827	Mar. 11	4:44 a. m.	20 55 15	110 18 30	1,761	dk. br. M	69	70	35.5	...do	60
1828	...do ...	10:58 a. m.	21 41 00	110 04 30	1,694	gn. M	72	74	35.4	...do	60
1829	...do ...	5:10 p. m.	22 25 30	109 42 15	1,711	gn. M	69	71	35.5	...do	60
1830	Mar. 20	6:24 p. m.	27 37 15	111 09 00	601	gn. M	70	66	39.8	...do	35
1831	Mar. 24	12:22 a. m.	28 44 15	112 32 15	89	S. brk Sh	64	61	64.2	...do	38
1832	Mar. 27	4:41 a. m.	31 23 00	114 25 00	10	M. S	66	65	65	Tanner	25
1833	...do ...	6:06 a. m.	31 13 30	114 27 15	18	M	66	63.9	63.9	...do	25
1834	June 7	11:57 a. m.	46 45 30	124 36 00	55	fne gy S	56	56	45.7	...do	25
1835	...do ...	12:24 p. m.	46 44 45	124 32 45	58	rky	56	56	45.1	...do	25
1836	June 8	8:27 a. m.	44 04 00	124 53 30	48	bu. M	54	52	48.6	...do	25
1837	...do ...	1:07 p. m.	43 54 30	124 47 30	95	M	59	57	43.9	...do	25
1838	...do ...	1:40 p. m.	43 57 30	124 49 00	61	M & G	59	57	47.3	...do	25
1839	...do ...	2:00 p. m.	44 59 30	124 50 30	43	M. & G	57	56	52.1	...do	25
1840	...do ...	5:55 p. m.	44 09 30	124 51 30	95	fne bk. S	57	56	43.6	...do	25
1841	...do ...	6:32 p. m.	44 11 15	124 48 15	68	G	57	56	......	...do	25
1842	...do ...	8:40 p. m.	44 16 00	124 42 00	70	G	56	56	45.9	...do	25
1843	...do ...	9:43 p. m.	44 19 00	124 40 00	61	G	57	55	46.4	...do	25
1844	...do ...	10:40 p. m.	44 22 15	124 38 00	60	M & G	57	55	......	...do	25
1845	...do ...	11:35 p. m.	44 25 30	124 36 00	73	fne. gy. S	57	55	47.2	...do	25
1846	June 9	12:35 a. m.	44 28 30	124 34 00	78	fne. bk. S	57	55	45.6	...do	25
1847	...do ...	1:30 a. m.	44 31 15	124 31 45	75	Gl	56	56	45.1	...do	25
1848	...do ...	2:22 a. m.	44 34 30	124 29 15	60	rky	56	56	45.8	...do	25
1849	...do ...	3:21 a. m.	44 37 30	124 27 00	59	fne P. and bk. S.	57	57	46.6	...do	25
1850	...do ...	4:00 a. m.	44 40 15	124 25 00	57	fne. bk. S	57	57	46.6	...do	25
1851	...do ...	5:03 a. m.	44 43 30	124 22 30	65	fne. gy. S	56	57	46.6	...do	25
1852	...do ...	5:48 a. m.	44 41 00	124 16 15	45	fne. gy. S. bk. Sp.	56	57	46.1	...do	25
1853	...do ...	6:25 a. m.	44 39 00	124 11 00	34	fne. gy. S	55	57	46.1	...do	25
1854	June 13	10:06 a. m.	45 55 30	124 01 15	25	fne. gy. S	56	54	48.6	...do	25
1855	June 14	10:12 a. m.	48 29 00	124 55 15	45	rky. & G	56	54	46.6	...do	25
1856	...do ...	10:26 a. m.	48 29 30	124 56 30	31	G. & brk. Sh	56	54	47.1	...do	25
1857	June 29	4:55 a. m.	47 23 00	125 44 00	860	gn. M	57	54	36.7	Sigsbee	35

Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July 1, 1888, to June 30, 1889.

Serial No.	Date.	Time.	Position. Latitude, N.	Position. Longitude, W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Drift. Direction.	Drift. Distance.	Instrument used.
	1888.		° ′ ″	° ′ ″	*Fms.*		°F.	°F.	°F.		*Miles.*	
2841	July 23	9:05 a. m.	54 18 00	165 55 00	56	P	53	46	41	WNW	0.2	S. B. T.
2842	..do	10:27 a. m.	54 15 00	166 03 00	72	P	50	46	41	SW.	0.3	S. B. T.
2843	July 28	12:37 p. m.	53 56 00	165 56 00	45	brk. Sh. & P	52	50	43.5	ENE	1.5	S. B. T.
2844	..do	2:47 p. m.	53 56 00	165 40 00	54	gy. S	51	48	42	E. by S	1.5	L. B. T.
2845	July 29	8:30 a. m.	54 05 00	164 09 00	42	crs. bk. S	53	51	42	SW	0.8	L. B. T.
2846	July 30	7:45 a. m.	54 08 00	162 44 00	44	G	51	50	42	S. by E	0.5	L. B. T.
2847	July 31	8:00 a. m.	55 01 00	160 12 00	48	fne. gy. S	51	51	42	SSW	0.8	L. B. T.
2848	..do	9:40 a. m.	55 10 00	160 18 00	110	gn. M	51	49	41	S	0.3	L. B. T.
2849	Aug. 2	7:30 a. m.	55 16 00	160 28 00	69	gn. M	54	51	43	S	0.7	L. B. T.
2850	Aug. 4	10:00 a. m.	54 52 00	159 46 00	21	brk. sh	53	51	48.2	W. by N	0.5	L. B. T.
2851	..do	11:15 a. m.	54 55 00	159 52 00	35	gy. s. brk. sh	53	51	44.8	W. by N	1.0	L. B. T.
2852	..do	4:08 p. m.	55 15 00	159 37 00	58	bk. s	53	48	41.8	NNW	0.7	L. B. T.
2853	Aug. 9	2:04 p. m.	56 00 00	154 20 00	139	gy. s	55	55	41	N. ¾ E	1.0	L. B. T.
2854	Aug. 10	9:55 a. m.	56 55 00	153 04 00	60	bk. s	57	55	42.8	SW	1.0	L. B. T.
2855	..do	11:44 a. m.	57 00 00	153 18 00	69	gn. m	58	56	44	NNW	1.0	L. B. T.
2856	Aug. 22	11:35 a. m.	58 07 00	151 36 00	68	gy. Sh. bk. Sp	55	54	44	NW	0.5	L. B. T.
2857	..do	6:30 p. m.	58 05 00	150 46 00	51	brk. Sh. gy. S	68	57	44.6	SE. ¼ E	0.5	L. B. T.
2858	Aug. 24	11:40 a. m.	58 17 00	148 36 00	230	bu. M. G	61	59	39.8	W. S. W	0.2	L. B. T.
2859	Aug. 29	2:00 p. m.	55 20 00	136 20 00	1,569	gy. Oz	61	60	34.9	SE	2.5	L. B. T.
2860	Aug. 31	9:30 a. m.	51 23 00	130 34 00	876	gn. M	61	58	36.5	E. ½ N	1.5	L. B. T.
2861	..do	2:50 p. m.	51 14 00	129 50 00	204	No specimen in cup	69	60	42.6	E	1.0	L. B. T.
2862	Sept. 1	12:32 p. m.	50 49 00	127 36 30	238	gy. S. & P	61	58	44.7	ESE	0.5	L. B. T.
2863	Sept. 5	10:58 a. m.	48 58 00	123 10 00	67	fne. S. brk. Sp	60	62	48.5	SSE	0.8	L. B. T.
2864	Sept. 6	7:16 a. m.	48 22 00	122 51 00	48	M. brk. sh. S	59	52	47.7	SSW	0.5	L. B. T.
2865	do	8:56 a. m.	48 12 00	122 49 00	40	P	58	52	51.7	S. by E	0.6	L. B. T.
2866	Sept. 20	11:10 a. m.	48 09 00	125 03 00	171	gy. S	59	59	43.2	SE. by E	0.8	L. B. T.
2867	..do	1:47 p. m.	48 07 00	124 55 00	37	fne. gy. S	58	58	....	S. E	0.8	L. B. T.
2868	Sept. 21	1:27 p. m.	47 52 00	124 44 00	31	gy. S	63	58	46.9	SE	0.5	L. B. T.
2869	..do	4:09 p. m.	47 38 00	124 39 00	32	bk. S	64	60	48.4	W	1.0	L. B. T.
2870	Sept. 23	9:04 a. m.	46 44 00	124 32 00	58	rky	58	58	46.5	E. by S	1.5	L. B. T.
2871	..do	1:32 p. m.	46 55 00	125 11 00	559	br. Oz	60	62	38.4	NW	1.3	L. B. T.
2872	Sept. 24	10:09 a. m.	48 17 00	124 52 00	38	gy. S	62	59	45.5	ENE	0.4	L. B. T.
2873	..do	12:45 p. m.	48 30 00	124 57 00	40	R	61	54	47.8	W	0.3	L. B. T.
2874	..do	1:25 p. m.	48 30 00	124 57 00	27	R. & Sh	55	52	50.3	SE	0.2	Tangles.
2875	..do	1:58 p. m.	48 30 00	124 57 00	40	R. & Sh	55	52	47.8	WSW	0.4	Tangles.
2876	Sept. 25	10:34 a. m.	48 33 00	124 53 00	59	bk. S. & M	58	49	45.5	WSW	0.4	L. B. T.
2877	..do	10:59 a. m.	48 33 00	124 53 00	59	bk. S. & M	58	49	45.5	SE. by S	0.2	Tangles.
2878	..do	3:02 p. m.	48 37 00	125 32 00	66	P	60	57	45.5	S	0.3	S. D.
2879	Sept. 26	8:35 a. m.	48 53 00	125 53 00	34	R	56	54	50.3	WNW	0.2	S. D.
2880	..do	8:49 a. m.	48 53 00	125 53 00	34	R	56	54	50.3	E. by S	0.2	S. D.
2881	..do	11:44 a. m.	49 00 00	125 48 00	24	gy. S	63	57	52.3	SE ¼ E	0.2	S. D.
2882	Oct. 13	2:12 p. m.	46 09 00	124 22 30	68	gy. S	64	60	45.8	N	1.0	L. B. T.

Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time.	Position. Latitude, N.	Position. Longitude, W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Drift. Direction.	Drift. Distance.	Instrument used.
	1888.		° ′ ″	° ′ ″	*Fms.*		° F.	° F.	° F.		*Miles.*	
2883	Oct. 18	3:01 p. m.	45 56 00	124 01 30	29	fne. gy. S	62	60	50.1	SSE	0.2	S. D.
2884	...do	3:16 p. m.	45 55 00	124 02 00	29	fne. gy. S	62	60	50.2	WNW. by N	0.3	S. D.
2885	...do	3:44 p. m.	45 56 00	124 02 00	30	fne. gy. S	62	60	49	NW	0.5	S. D.
2886	Oct. 19	9:05 a. m.	43 59 00	124 56 30	50	rky	57	57	48.1	SSW	0.2	S. D.
2887	...do	9:28 a. m.	43 58 00	124 57 00	42	C. & P	60	59	47.1	SW	0.4	L. B. T.
2888	...do	10:01 a. m.	43 58 00	124 57 30	41	C. & P	60	59	47.6	W	0.1	L. B. T.
2889	...do	10:42 a. m.	43 59 00	124 56 00	46	C. Sh	59	57	47.7	SSW	0.4	L. B. T.
2890	...do	2:58 p. m.	43 46 00	124 57 00	277	gy. S	62	59	42.2	SSE	2.3	L. B. T.
	1889.											
2891	Jan. 5	6:36 a. m.	34 25 00	120 42 00	233	M	56	57	45.1	E. by S	1.0	L. B. T.
2892	...do	9:10 a. m.	34 15 00	120 36 00	284	yl. M	56	57	44.1	SSE	2.0	L. B. T.
2893	...do	11:11 a. m.	34 12 30	120 32 30	145	fne. gy. S. M	60	59	48.6	SE. ½ E	1.0	L. B. T.
2894	...do	12:41 p. m.	34 07 00	120 33 30	53	brk. Sh. S	62	60	55.6	NNE	0.1	S. D.
2895	...do	1:15 p. m.	34 07 00	120 33 30	53	brk. Sh. S	62	60	.....	NNE	0.1	Tangles.
2896	Jan. 6	6:49 a. m.	33 55 30	120 28 00	376	yl. M	59	59	42.8	.....	.....	L. B. T.
2897	...do	9:35 a. m.	33 59 30	120 29 30	197	rky	66	61	47.1	.....	.....	Tangles.
2898	...do	11:02 a. m.	33 00 30	120 29 00	158	.....	66	61	.....	.....	.....	L. B. T.
2899	...do	1:08 p. m.	34 00 00	120 23 00	44	gy. S. brk. Sh	62	59	.....	.....	.....	L. B. T.
2900	Jan. 7	11:59 a. m.	34 01 30	120 01 30	13	S	59	58	.....	0	0.0	S. D.
2901	...do	12:40 p. m.	34 05 00	120 02 00	48	gy. S. M	59	58	55.1	WNW	0.8	
2902	...do	1:04 p. m.	34 06 00	120 02 00	53	fne. gy. S. M	60	59	45.0	W	0.9	S. B. T.
2903	...do	2:22 p. m.	34 11 30	120 03 00	322	G. M	60	59	43.5	NW. by W	1.5	L. B. T.
2904	...do	4:29 p. m.	34 18 30	120 04 30	314	G. M	61	59	43.7	NW. by W	1.3	L. B. T.
2905	Jan. 8	6:41 a. m.	34 23 00	120 20 00	95	rky	61	59	.....	.....	.....	S. B. T.
2906	...do	7:15 a. m.	34 23 30	120 19 30	96	S. M	57	58	55.5	.....	.....	Tangles.
2907	...do	7:48 a. m.	34 24 30	120 20 00	44	fne. gy. S	57	58	.....	NNW	0.3	L. B. T.
2908	...do	8:29 a. m.	34 25 25	120 20 00	31	gy. S. brk. Sh	57	58	.....	N. by W	0.8	L. B. T.
2909	...do	12:15 p. m.	34 22 00	120 08 30	205	gn. M	57	59	45.2	ENE. ½ E	0.5	S. B. T.
2910	...do	2:51 p. m.	34 20 00	119 54 00	229	gn. M	60	61	45.2	E. by S	0.8	S. B. T.
2911	Jan. 16	9:42 a. m.	32 27 30	119 05 00	60	R. S	59	59	.....	S	0.3	S. D.
2912	...do	11:33 a. m.	32 25 15	119 04 30	10	rky	56	59	.....	E	0.2	Tangles.
2913	...do	11:57 a. m.	32 25 30	119 03 30	26	brk. Sh	60	60	59.0	ESE	0.3	S. D.
2914	...do	12:14 p. m.	32 25 00	119 03 15	26	brk. Sh	60	60	59	WNW	0.4	Tangles.
2915	...do	3:22 p. m.	32 23 30	119 02 15	55	gy. S	58	60	53.1	SE. by S	0.3	Tangles.
2916	...do	3:45 p. m.	32 22 30	119 02 00	93	rky	58	60	49.1	W. by S	0.8	L. B. T.
2917	...do	4:10 p. m.	32 22 30	119 03 30	90	fne. g. S. brk. Sh	58	59	49.1	0	0	S. D.
2918	...do	4:41 p. m.	32 22 30	119 03 30	67	fne. gy. S	58	59	52.4	0	0	S. D.
2919	Jan. 17	6:28 a. m.	32 17 00	119 17 00	984	gy. M	55	59	38	N. ½ E	0.2	L. B. T.
2920	...do	12:37 p. m.	32 27 00	119 15 00	87	yl. S. brk. Sh	59	60	50.1	.....	.....	S. D. and Tangles.
2921	...do	1:15 p. m.	32 27 00	119 14 15	145	fne. gy. S	59	60	51.5	.....	.....	S. D.
2922	...do	5:10 p. m.	32 27 15	119 05 15	47	fne. gy. S	60	50	57.1	NNE	0.4	S. D.
2923	Jan. 19	6:30 a. m.	32 40 30	117 31 30	822	gn. M	55	59	39	SE	1.5	L. B. T.
2924	...do	10:00 a. m.	32 34 30	117 25 30	455	br. M	57	59	40.5	SE	2.5	L. B. T.
2925	...do	12:10 p. m.	32 32 30	117 24 00	339	M	56	59	42.9	E. ½ S	2.0	L. B. T.

2926	...do....	1:48 p.m.	32 34 30	117 18 45	69	fne. gy. S	63	62	54.4	NE. by N	1.5	L. B. T.
2927	Jan. 23	11:25 a.m.	32 43 00	117 51 00	313	gn. M	56	58	43.3	W. $\frac{1}{8}$ S	1.9	L. B. T.
2928	...do	2:44 p.m.	32 47 30	118 10 00	417	bk. S. G	58	59	41	W. by S	0.7	L. B. T.
2929	Jan. 26	6:25 a.m.	32 27 30	117 26 30	623	gn. M	56	58	....	S. by W	1.6	S. B. T.
2930	...do...	9:09 a.m.	32 25 00	117 18 45	60	M	59	59	52.9	E. by N	0.6	S. B. T.
2931	...do....	10:19 a.m.	32 25 30	117 16 45	34	gy. S. Sh	58	59	55.9	ENE	0.5	S. B. T.
2932	...do....	10:50 a.m.	32 26 15	117 16 15	20	gy. S. brk. Sh	58	59	58	E	0.4	S. B. T.
2933	...do...	11:45 a.m.	32 28 45	117 16 15	36	fne. gy. S	58	59	57.3	N	0.5	S. D.
2934	..do...	12:40 p.m.	32 33 30	117 16 00	36	gy. S	53	59	58.2	N	1.5	L. B. T.
2935	Feb. 4	11:00 a.m.	32 44 30	117 23 00	124	fne. gy. S	68	59	49.2	NW. $\frac{3}{4}$ W	0.8	L. B. T.
2936	..do....	12:22 p.m.	32 49 00	117 27 30	359	M	61	61	49	NW. $\frac{3}{4}$ W	1.0	L. B. T.
2937	..do....	4:09 p.m.	33 04 30	117 42 00	464	gn. M	65	62	46.5	West	1.5	L. B. T.
2938	Feb. 5	12:58 p.m.	33 35 15	118 08 30	47	fne. gy. S. St	56	58	58	....	....	L. B. T.
2939	...do....	1:45 p.m.	33 36 00	118 09 30	27	fne. gy. S. St	58	59	....	WNW	0.5	L. B. T
2940	...do....	2:47 p.m.	33 36 00	118 11 00	26	fne. gy. S. brk. Sh	58	59	....	....	....	L. B. T.
2941	...do....	3:11 p.m.	33 37 15	118 12 00	26	Sh. St	59	59	....	....	0.5	L. B. T.
2942	...do....	3:58 p.m.	33 38 45	118 13 45	20	gy. S. brk. Sh	59	59	....	SW. by S	0.2	L. B. T.
2943	Feb. 6	1:10 p.m.	34 00 30	119 28 30	31	rky	58	59	56	SSE	0.2	S. D.
2944	...do....	1:26 p.m.	34 00 00	119 28 30	30	rky	58	59	....	SW. by W	0.3	S. B. T.
2945	...do....	2:34 p.m.	34 00 00	119 29 30	30	P	58	59	....	SW. by W. $\frac{1}{2}$ W.	0.4	S. B. T.
2946	...do....	3:20 p.m.	33 58 00	119 30 45	150	Crs. gy. S	60	59	56.5	NE. $\frac{1}{2}$ N	0.2	L. B. T.
2947	Feb. 7	1:44 p.m.	33 55 30	119 40 30	269	gy. S. G. brk. Sh	59	59	....	SW	0.3	L. B. T.
2948	..do....	2:27 p.m.	33 55 30	119 41 30	266	gy. S. G. brk. Sh	59	59	....	SW. $\frac{1}{2}$ W	0.7	L. B. T.
2949	..do....	4:34 p.m.	33 57 00	119 53 30	155	fne. gy. S	59	58	....	W. by S	0.7	L. B. T.
2950	Feb. 8	6:26 a.m.	34 00 30	119 59 00	21	gy. S. brk. Sh	57	57	55.4	NE. by E	1.0	L. B. T.
2951	...do...	7:41 a.m.	33 55 30	119 55 00	48	fne. gy. S	57	56	....	SW. by S	0.8	L. B. T.
2952	...do....	8:50 a.m.	33 50 00	119 57 00	57	brk. Sh. R	57	57	....	SW	0.1	L. B. T.
2953	...do....	9:40 a.m.	33 47 00	119 58 15	82	gy. S. brk. Sh	57	57	....	SW. by W	0.5	S. D.
2954	..do....	10:45 a.m.	33 42 30	119 59 30	65	G. Sh. R	58	57	....	....	....	S. D.
2955	..do....	12:19 p.m.	33 48 00	120 03 15	121	fne. gy. S. brk. Sh	60	59	48.2	WSW	0.3	S. B. T.
2956	..do....	3:13 p.m.	33 57 30	120 18 30	52	fne. gy. S. R	58	58	53.1	SW. by W	0.1	S. B. T.
2957	Feb. 9	12:39 p.m.	34 04 00	120 19 30	26	gy. S. rky	63	58	54.9	....	....	S. D.
2958	...do....	12:49 p.m.	34 04 00	120 19 30	26	gy. S	63	58	54.9	SSE. $\frac{1}{2}$ E NW. by W. $\frac{1}{2}$ W.	0.3 0.3	Tangles.
2959	...do....	1:48 p.m.	34 06 45	120 18 00	55	gn. M. gy. S. brk. Sh	63	59	51.9	N. $\frac{3}{4}$ W	1.0	L. B. T.
2960	...do....	2:47 p.m.	34 10 45	120 16 45	267	gn. M	63	59	48	W. $\frac{1}{8}$ S	1.0	L. B. T.
2961	Feb. 11	7:35 a.m.	34 22 45	119 40 30	21	gn. M	53	58	....	N. $\frac{3}{4}$ W	0.4	L. B. T.
2962	...do....	8:04 a.m.	34 23 30	119 39 30	165	S. St. Co	62	59	....	S. $\frac{1}{4}$ E	0.3	L. B. T.
2963	..do....	8:17 a.m.	34 23 10	119 39 40	20	S. St. Co	62	59	....	SW. by S	0.5	Tangles.
2964	Feb. 11	8:47 a.m.	34 22 45	119 40 00	21½	S. St	62	59	....	NE N. $\frac{1}{8}$ W	0.5 0.3	Tangles.
2965	...do....	9:58 a.m.	34 21 20	119 38 30	27	fne. gy. S. R	62	60	58	SSW	0.3	Tangles.
2966	...do....	10:25 a.m.	34 20 40	119 38 50	30	crs. M	62	60	58.5	NE	0.7	Tangles.
2967	.do...	10:58 a.m.	34 21 15	119 39 10	30	crs. M	62	60	58	NW. $\frac{1}{2}$ N	0.6	Tangles.
2968	..do..	11:25 a.m.	34 21 40	119 38 20	31	M	66	61	59	SE. by E	0.7	Tangles.
2969	.do....	12:05 p.m.	34 20 40	119 37 45	26	gy. S. P. St	66	61	58	SE. by E. $\frac{1}{2}$ E	0.5	Tangles.
2970	..do...	12:32 p.m.	34 20 20	119 37 30	29	fne. gy. S. M	63	61	59.1	W. by N	0.3	L. B. T.
2971	..do....	1:17 p.m.	34 20 30	119 37 50	29	fne. gy. S. M	63	60	58.5	S. by E	0.7	L. B. T.
2972	...do..	2:17 p.m.	34 18 30	119 41 00	61	gn. M	63	60	53.5	WSW	1.0	L. B. T.
2973	...do....	3:08 p.m.	34 19 30	119 44 15	68	gn. M	63	60	54	....	....	L. B. T.
2974	..do....	3:47 p.m.	34 19 30	119 44 45	73	gn. M	63	60	53.2	WSW N. by W. $\frac{3}{4}$ W	0.7 0.8	Tangles.

Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time.	Position. Latitude, N.			Position. Longitude, W.			Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Drift. Direction.	Drift. Distance.	Instrument used.
	1889.		°	′	″	°	′	″	*Fms.*		°F.	°F.	°F.		*Miles.*	
2975	Feb. 12	8:34 a. m.	34	01	30	119	29	00	36	G. brk. Sh	65	60	57	SE. ¾ E	1.0	L. B. T.
2976	...do...	9:22 a. m.	34	00	00	119	26	30	31	crs. G. S. brk. Sh	65	60	58	SE. by E	0.5	S. B. T.
2977	...do...	9:55 a. m.	33	59	30	119	25	30	45	fne. gy. S. P	65	60	56.5	E	0.8	S. B. T.
2978	...do...	10:42 a. m.	33	59	45	119	22	15	46	gy. S	70	60	56.5	NE. ¼ E	0.3	S. B. T.
2979	...do...	12:28 p. m.	33	56	30	119	22	30	388	gn. M	65	60	....	SW. by S	1.5	L. B. T.
2980	...do...	2:40 p. m.	33	49	45	119	24	30	603	gn. M	70	62	38.9	E	0.5	L. B. T.
2981	Feb. 13	6:10 a. m.	33	18	00	119	24	00	45	crs. gy. S. brk. Sh	61	58	....	SE. ½ S	0.7	L. B. T.
2982	...do...	11:40 a. m.	33	24	45	119	07	00	178	S. M. G	63	58	46.7	NE	0.5	L. B. T.
2983	Feb. 28	11:11 a. m.	28	58	30	118	15	45	58	gy. S. brk. Sh	71	61	55.8	S	0.7	S. B. T.
2984	...do...	11:48 a. m.	28	57	15	118	15	45	113	gy. S. brk. Sh	68	63	49.8	SW. by W	0.7	S. B. T.
2985	...do...	1:00 p. m.	28	57	00	118	16	30	36	brk. Sh. R	66	65	....	N. by E	0.2	S. B. T.
2986	...do...	1:37 p. m.	28	57	00	118	14	30	684	fne. gy. S. brk. Sh	67	64	38.5	S	0.6	L. B. T.
2987	...do...	4:31 p. m.	28	54	15	118	18	00	171	gy. S. bk. sp. G	65	63	46.3	SW. by W	0.7	S. B. T.
2988	Mar. 2	9:10 a. m.	24	58	30	115	52	30	34	Coralline	66	65	63.9	SW. ½ W	0.3	Tangles.
2989	Mar. 2	9:51 a. m.	24	58	15	115	53	00	36	Coralline	64	64.5	64.3	SSW. ½ W	0.3	S. D.
2990	...do...	11:09 a. m.	24	58	05	115	53	10	48	Coralline	64	65	63.6	S. by W. ¼ W	0.5	S. B. T.
2991	Mar. 6	9:55 a. m.	18	18	30	114	40	00	341	....	75	72	....	SW. by W. ½ W	1.3	L. B. T.
2992	...do...	11:28 a. m.	18	17	30	114	43	15	460	bk. S. R	71	72	41.8	W. ½ N	0.3	L. B. T.
2993	...do...	1:24 p. m.	18	17	15	114	44	30	364	gy. S. brk. Sh	72	72	43.5	NW. by N	0.3	L. B. T.
2994	...do...	2:58 p. m.	18	18	30	114	44	30	54	brk. Co	72	72	66.6	NE. by N	0.4	S. D.
2995	...do...	3:31 p. m.	18	19	00	116	44	15	31	gy. S. brk. Co	72	72	68.4	NE. by N	0.4	S. D.
2996	Mar. 16	11:05 a. m.	24	30	15	110	29	00	112	gn. M	76	72	56	N. by W	0.3	L. B. T.
2997	...do...	1:26 p. m.	24	39	30	110	34	00	221	gn. M	75	73	49.5	NW. ⅝ N	0.6	L. B. T.
2998	...do...	3:37 p. m.	24	51	00	110	39	00	40	S. brk. Sh	75	72	64	N. by E. ¼ E	1.0	L. B. T.
2999	...do...	4:40 p. m.	24	54	30	110	39	00	39	crs. S	74	72	63.6	NW.	0.5	L. B. T.
3000	...do...	5:10 p. m.	24	54	45	110	39	30	43	crs. S	76	72	61.5	NE. by N	0.5	Oyster dredge.
3001	...do...	5:32 p. m.	24	55	15	110	39	00	33	fne. gy. S. brk. Sh	72	72	64.5	N. by W. ½ W	0.3	Oyster dredge.
3002	Mar. 17	7:08 a. m.	25	02	15	110	43	30	17	S. Sh	72	70	....	N. by W	0.2	Oyster dredge.
3003	...do...	7:25 a. m.	25	02	25	110	43	30	9	S. Sh	72	70	....	N by W	0.2	Oyster dredge.
3004	...do...	7:40 a. m.	25	02	35	110	43	30	7½	S. Sh	72	70	....	N. by W	0.2	L. B. T.
3005	...do...	8:00 a. m.	25	02	45	110	43	30	21	S. Sh. Coralline	75	71	....	S. by E	0.2	L. B. T.
3006	...do...	8:23 a. m.	25	02	30	110	43	30	8	Shs	75	75	....	S. by E	0.2	L. B. T.
3007	...do...	12:33 p. m.	25	27	30	110	50	30	362	gn. M	69	69	44.6	NNE	1.3	L. B. T.
3008	Mar. 18	4:12 p. m.	25	59	45	111	03	30	306	M	70	67	46	N	0.6	L. B. T.
3009	Mar. 20	4:51 a. m.	27	09	00	111	42	00	857	gn. M	67	66	37.7	NE. by N	1.5	L. B. T.
3010	...do...	10:45 a. m.	27	23	45	111	25	00	1,005	gn. M	74	71	37.6	NE. ⅝ N	1.8	L. B. T.
3011	Mar. 23	1:55 p. m.	28	07	00	111	39	45	71	fne. gy. S. brk. Sh	67	69	57.9	NW. by W	1.0	L. B. T.
3012	...do...	4:36 p. m.	28	16	00	111	54	00	22	fne. gy. S	67	69	63	N. by W	1.5	L. B. T.
3013	...do...	6:25 p. m.	28	23	45	111	58	00	14	gy. S. brk. Sh	68	66	65	WSW	0.5	L. B. T.
3014	Mar. 23	7:35 p. m.	28	28	00	112	04	30	29	gy S	68	66	62.9	W	0.5	L. B. T.
3015	Mar. 24	5:40 a. m.	29	19	00	112	50	00	145	br. M	64	63	54.9	N. by E	1.0	L. B. T.
3016	...do...	9:01 a. m.	29	40	00	112	57	00	76	gn. M	70	65	59	NNW. ¼ W	1.3	L. B. T.

3017	...do	11:19 a. m.	29 54 30	113 01 00	58	gn. M	72	66.5	61.8	NNW. ½ W	1.3	L. B. T.
3018	...do ...	2:21 p. m.	30 16 00	113 05 00	36	gy S. brk Sh	72	66	63.3	N. by E. ½ E.....	2.0	L. B. T.
3019	.. do ...	4:09 p. m.	30 28 00	113 06 30	14	bk S. brk Sh	67	66	66	N. by E	0.5	L. B. T.
3020	...do ...	5:48 p. m.	30 37 30	113 07 00	7	gy S. bk Sp	67	65	....	NW. by W	0.4	L. B. T.
3021	...do ...	7:25 p. m.	30 47 00	113 13 00	14	gy S. brk Sh........................	67	65	....	NW. ½ W	1.0	L. B. T.
3022	...do	9:00 p. m.	30 58 30	113 17 15	11	gy S. bk Sp	66	66.1	66.1	WNW	1.3	L. B. T.
3023	Mar. 25	4:06 p. m.	31 17 30	113 57 15	10	G. Sh	69	67	....	WSW	0.7	L. B. T.
3024	...do ...	5:42 p. m.	31 21 00	113 49 00	11	S. brk Sh. G........................	68	67	67	NW. ½ N........	0.8	L. B. T.
3025	...do	7:16 p. m.	31 21 15	113 59 00	9½	fne. gy S	67	67	66.1	W. by S..........	1.3	L. B. T.
3026	.. do	8:32 p. m.	31 22 00	114 07 45	17	G. brk Sh	67	66	65.2	W. by N	0.5	L. B. T.
3027	Mar. 26	3:22 p. m.	31 31 45	114 19 00	10	gy S	68	68	....	W. by N	0.1	L. B. T.
3028	...do ...	3:53 p. m.	31 32 30	114 20 00	9¾	S	70	68	....	W. ½ N..........	0.5	L. B. T.
3029	...do ..	4:27 p. m.	31 33 00	114 20 30	10½	fne gy S. brk Sh..................	70	68	....	NW. by W	0.8	L. B. T.
3030	Mar. 27	7:08 a. m.	31 07 00	114 29 00	20	M........................	66	65	64	SE	0.8	L. B. T.
3031	...do	7:40 a. m.	31 06 45	114 28 15	33	bn M	66	65	63.8	SW..............	0.8	L. B. T.
3032	...do ...	8:12 a. m.	31 05 30	114 29 00	12	gy S	67	65	....	SSW	0.4	L. B. T.
3033	...do ...	10:17 a. m.	30 50 45	114 29 45	18	gy M	67	65.7	63.5	SE. ½ E	1.0	L. B. T.
3034	...do ...	12:31 p. m.	30 36 30	114 27 45	24	gy M	67	69.5	63.5	SE. ½ E	1.5	L. B. T.
3035	...do ...	2:37 p. m.	30 21 00	114 25 15	30	gy M	70	70	62	SE. ½ S..........	1.0	L. B. T.
3036	Mar. 29	9:14 a. m.	29 47 15	114 24 00	5	M. S. brk Sh	73	67	....	SE	0.2	L. B. T.
3037	Mar. 31	9:40 a. m.	27 45 00	110 45 00	20	gn. M	77	69	65.2	SE. by E. ½ E....	0.8	L. B. T.
3038	Apr. 8	9:11 a. m.	24 24 30	111 53 00	31	gy S. brk Sh	66	67	65.5	NW. ½ N........	0.8	L. B. T.
3039	Apr. 8	10:31 a. m.	24 27 00	111 59 00	47	fne. yl. S	66	67	68.5	W. ½ N	1.0	L. B. T.
3040	Apr. 9	2:17 p. m.	24 35 00	112 04 30	21	S. Sh	69	68	....	NW	0.6	Oyster dredge.
3041	..do	2:38 p. m.	24 35 30	112 05 00	27	fne. gy S........................	69	68	64.5	NW. by W. ½ W.	1.1	L. B. T.
3042	...do ..	3:35 p. m.	24 38 00	112 05 30	17	fne. gy S........................	67	67	65	NNW. ½ W	0.8	L. B. T.
3043	Apr. 10	11:33 a. m.	26 07 00	113 32 00	74	fne. gy S........................	65	64	55	W. ½ S	1.5	L. B. T.
3044	...do ...	2:30 p. m.	26 16 15	113 42 15	58	gy S. brk Sh	65	64	56	W. ½ S	1.0	L. B. T.
3045	.do ..	4:03 p. m.	26 24 00	113 49 00	184	M........................	64	65	48	WSW	1.0	L. B. T.
3046	June 7	9:22 a. m.	46 48 30	124 28 00	48	fne. gy S........................	55	56	46.1	SSW. ½ W	1.5	L. B. T.
3047	...do ...	10:11 a. m.	46 47 00	124 30 15	50	fne. gy S........................	55	57	45.9	SSW	2.0	L. B. T.
3048	.. do ...	10:57 a. m.	46 45 30	124 33 00	52	Rky	56	58	41.1	W. by S..........	2.0	L. B. T.
3049	.. do ...	3:10 p. m.	46 31 00	124 22 00	43	fne. blk. S........................	59	57	46.7	SSE	1.2	L. B. T.
3050	June 8	8:46 a. m.	44 01 15	124 57 00	46	Co. brk. Sh........................	56	54	56.1	....	....	L. B. T.
3051	..do	9:57 a. m.	43 59 15	124 58 30	59	Co. brk. Sh. Rky	57	55	....	N. by W	1.2	Tangles.
3052	...do ...	10:33 a. m.	44 00 00	124 57 00	48	Co. brk. Sh. Rky	57	55	49	N. by S	0.5	Tangles.
3053	. do ...	4:47 p. m.	44 04 30	124 50 00	64	Co. brk. Sh. Rky	61	56	47.3	NW. by N	0.7	Tangles.
3054	do ..	7:04 p. m.	44 13 00	124 44 30	53	R........................	57	56	48	NW	0.2	Tangles.
3055	June 9	6:55 a. m.	44 41 30	124 09 15	28	fne. gy. S........................	55	57	47.4	NW. ½ N........	2.0	L. B. T.
3056	. do ...	7:58 a. m.	44 41 30	124 09 15	28	fne. gy S........................	54	57	47.4	W	1.5	L. B. T.
3057	. do ...	9:12 a. m.	44 43 31	124 15 45	43	crs. gy. S........................	55	52	45.7	NW. by W......	1.0	L. B. T.
3058	do ...	3:00 p. m.	44 48 00	124 10 00	38	crs. gy. S. Sh	55	53	45.8	N. by W	0.7	L. B. T.
3059	do ..	7:18 p. m.	44 56 00	124 12 30	77	M	58	53	45.1	....	....	L. B. T.
3060	June 13	6:52 a. m.	45 56 15	124 01 30	28	br. m	54	53	....	ESE	0.5	L. B. T.
3061	.. do	7:20 a. m.	45 55 30	124 01 00	23	fne. blk. S........................	54	53	48.4	WNW	1.0	L. B. T.
3062	. do ...	8:32 a. m.	46 55 45	124 05 00	44	fne. blk. S........................	54	54	45.2	E. by N..........	0.8	L. B. T.
3063	.. do	9:16 a. m.	46 55 15	124 04 30	42	fne gy S	56	54	45.8	NE. ½ N	1.1	L. B. T.
3064	..do ...	12:33 p. m.	46 03 15	124 09 00	46	fne. gy. S. G	57	58	45.6	NW. ½ N........	1.0	L. B. T.
3065	..do	2:36 p. m	46 14 30	124 13 00	27	fne. bk. S	58	57	....	NE	1.0	L. B. T.
3066	.. do ...	5:25 p. m.	46 26 30	124 26 00	55	S. M........................	58	57	45.6	WNW.	1.0	L. B. T.
3067	June 18	1:38 p. m.	47 36 00	122 23 15	82	gn. M........................	58	56	....	SW. by W..	1.5	L. B. T.
3068	...do	2:43 p. m.	47 35 30	122 27 00	135	gn. M........................	60	58	....	N. by E..........	1.5	L. B. T.

Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July 1, 1888, to June 30, 1889—Continued.

Serial No.	Date.	Time.	Position. Latitude, N.	Position. Longitude W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Drift. Direction.	Drift. Distance	Instrument used.
	1889.		° ′ ″	° ′ ″	*Fms.*		°F.	°F.	°F.		*Miles.*	
3069	June 28	7:41 a. m.	47 25 30	125 42 00	760	gn. M	56	56	37.6	WNW	2.0	L. B. T.
3070	...do	10:56 a. m.	47 29 30	125 43 00	636	gn. M	57	57	37.9	E	2.0	L. B. T.
3072	...do	1:33 p. m.	47 29 00	125 33 30	685	gn. M	56	55	38	E. by N	1.5	L. B. T.
3072	...do	4:29 p. m.	47 28 30	125 24 00	584	gn. M	56	55	38.2	ENE	2.0	S. B. T.
3073	...do	6:48 p. m.	47 28 00	125 15 00	477	gn. M	56	55	49.2	E	2.0	S. B. T.
3074	June 29	6:35 a. m.	47 22 00	125 48 30	877	gn. M	57	54	36.6	E	1.5	L. B. T.
3075	...do	10:02 a. m.	47 22 00	125 41 00	859	gn. M	57	57	36.6	ESE	2.0	L. B. T.
3076	...do	4:35 p. m.	47 46 00	125 10 00	178	gn. M	57	59	43.4	ESE	2.5	L. B. T.

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1888, to June 30, 1889.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen when specific gravity was taken.	Observed specific gravity.	Specific gravity reduced to 60° F. with pure water at 60° F. as standard.	Specific gravity reduced to 15° C. with pure water at 4° C. as standard.
1888.			° ′ ″	° ′ ″	*Fms.*	°	°	°			
July 4	12 m	Off Ballenas Point.			Surface	59	63	70	1.0240	1.025450	1.024630
4	6 p. m		38 26 00	123 00 00	do	53	55	68	1.0244	1.025536	1.024716
4	12 p. m		39 04 00	123 31 00	do	50	52	68	1.0246	1.025736	1.024916
5	6 a. m		39 42 00	124 01 00	do	50	52	68	1.0246	1.025736	1.024916
5	12 m		40 21 00	124 29 00	do	48	52	68	1.0250	1.026136	1.025316
5	6 p. m		40 58 00	124 32 30	do	52	55	69	1.0244	1.025687	1.024867
5	12 p. m		41 35 00	124 36 00	do	53	52	69	1.0244	1.025687	1.024867
6	6 a. m		42 12 00	124 39 30	do	50	51	69	1.0244	1.025687	1.024867
6	12 m		42 50 00	124 43 00	do	48	53	69	1.0246	1.025887	1.025067
6	6 p. m		43 23 00	124 34 00	do	49	53	69	1.0244	1.025687	1.024867
6	12 p. m		43 56 00	124 23 00	do	48	54	69	1.0232	1.024487	1.023667
7	6 a. m		44 29 00	124 15 00	do	51	56	69	1.0232	1.024487	1.023667
7	12 m		45 04 00	124 04 00	do	50	55	69	1.0232	1.024487	1.023667
7	6 p. m		45 50 00	124 16 00	do	59	62	69	1.0226	1.023887	1.023067
7	12 p. m		46 36 00	124 28 00	do	58	59	69	1.0226	1.023887	1.023067
8	6 a. m		47 22 00	124 40 00	do	58	58	69	1.0212	1.022487	1.021667
8	12 m		48 09 00	124 51 00	do	56	61	69	1.0218	1.023087	1.022267
8	6 p. m	Victoria, B. C			do	52	58	69	1.0222	1.023487	1.022667
9	6 p. m	Gulf of Georgia			do	59	60	69	1.0146	1.015887	1.015067
11	4 p. m	Departure Bay			do	64	68	69	1.0146	1.015887	1.015067
11	6 p. m	Off Departure Bay			do	64	65	69	1.0146	1.015887	1.015067
11	12 p. m	Tribune Bay			do	59	57	68	1.0160	1.017136	1.016316
12	12 m	Johnston's Strait			do	56	56	62	1.0224	1.022670	1.021850
12	6 p. m	Off Beaver Harbor			do	50	55	69	1.0226	1.023887	1.023067
13	12 m	Beaver Harbor			do	55	56	68	1.0224	1.023536	1.022716
13	6 p. m	Off Cape Scott			do	56	56	68	1.0232	1.024336	1.023516
13	12 p. m		50 56 00	129 40 00	do	55	55	68	1.0236	1.024736	1.023916
14	6 a. m		51 05 00	131 02 00	do	56	55	68	1.0236	1.024736	1.023916
14	12 m		51 14 00	132 30 00	do	54	54	68	1.0236	1.024736	1.023916
14	6 p. m		51 29 00	133 40 00	do	54	55	68	1.0236	1.024736	1.023916
14	12 p. m		51 44 00	134 50 00	do	54	54	68	1.0234	1.024536	1.023716
15	6 a. m		51 59 00	136 00 00	do	53	53	68	1.0236	1.024736	1.023916
15	12 m		52 15 00	137 13 30	do	52	54	68	1.0236	1.024736	1.023916
15	6 p. m		52 18 00	138 33 00	do	53	53	68	1.0236	1.024736	1.023916
15	12 p. m		52 23 00	139 43 00	do	52	53	68	1.0236	1.024736	1.023916
16	6 a. m		52 29 00	141 03 00	do	51	51	68	1.0236	1.024736	1.023916
16	12 m		52 35 00	142 34 00	do	52	52	68	1.0236	1.024736	1.023916
16	6 p. m		52 37 00	143 44 00	do	52	52	68	1.0236	1.024736	1.023916
16	12 p. m		52 34 00	144 54 00	do	51	50	88	1.0236	1.024736	1.023916
17	6 a. m		52 36 00	146 04 00	do	50	50	68	1.0236	1.024736	1.023916
17	12 m		52 85 00	147 35 00	do	50	49	68	1.0236	1.024736	1.023916
17	6 p. m		52 26 00	148 29 00	do	50	50	68	1.0236	1.024736	1.023916
17	12 p. m		52 17 00	149 43 00	do	50	49	68	1.0236	1.024736	1.023916
18	6 a. m		52 08 00	150 57 00	do	50	49	68	1.0240	1.025136	1.024316
18	12 m		51 58 00	152 12 00	do	51	51	68	1.0240	1.025136	1.024316
18	6 p. m		52 04 00	153 35 00	do	51	52	68	1.0240	1.025136	1.024316
18	12 p. m		52 10 00	154 58 00	do	50	51	68	1.0240	1.025136	1.024316
19	6 a. m		52 15 00	156 37 00	do	51	51	68	1.0240	1.025136	1.024316
19	12 m		52 11 00	157 44 00	do	49	50	68	1.0240	1.025136	1.024316
19	6 p. m		52 13 00	158 58 00	do	48	50	68	1.0238	1.024936	1.024116
19	12 p. m		52 11 00	160 12 00	do	49	50	68	1.0240	1.025136	1.024316
20	6 a. m		52 15 00	161 40 30	do	50	50	68	1.0240	1.025136	1.024316
20	12 m		52 25 00	162 40 00	do	50	55	68	1.0240	1.025136	1.024316
20	6 p. m		52 18 00	163 54 00	do	50	54	68	1.0240	1.025136	1.024316
20	12 p. m		52 20 00	165 00 00	do	50	52	68	1.0238	1.024936	1.024116
21	12 m		52 50 00	166 42 00	do	50	52	68	1.0238	1.024936	1.024116
21	6 p. m		53 19 00	166 50 00	do	50	53	68	1.0236	1.024736	1.023916
21	12 p. m		53 16 00	166 10 00	do	49	51	68	1.0234	1.024536	1.023716
22	6 a. m		53 39 00	165 04 00	do	48	50	69	1.0232	1.024487	1.023667
22	12 m		53 40 00	164 28 30	do	50	52	69	1.0234	1.024687	1.023807
22	6 p. m		54 00 00	163 45 00	do	50	51	69	1.0234	1.024687	1.023867
22	12 p. m		54 13 00	164 02 00	do	49	51	69	1.0236	1.024887	1.024067
23	6 a. m		54 22 00	165 34 30	do	45	50	69	1.0236	1.024887	1.024067
23	12 m		54 10 00	166 13 00	do	45	52	69	1.0232	1.024487	1.023667
23	6 p. m	Unalaska harbor			do	52	59	69	1.0202	1.021487	1.020667
28	12 m		53 56 00	166 07 00	do	50	52	68	1.0240	1.025136	1.024316
28	6 p. m		53 55 00	165 05 30	do	51	52	68	1.0236	1.024736	1.023916

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1888, *to June* 30, 1889—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen when specific gravity was taken.	Observed specific gravity.	Specific gravity reduced to 60° F. with pure water at 60° F. as standard.	Specific gravity reduced to 15° C. with pure water at 4° C. as standard.
1888.			° ′ ″	° ′ ″	*Fms.*	°	°	°			
July 28	12 p. m		53 55 00	164 22 00	Surface.	50	50	68	1.0234	1.024536	1.023716
29	6 a. m		54 02 30	163 53 36	do	51	52	68	1.0234	1.024536	1.023716
29	12 m		54 11 00	164 46 00	do	50	51	68	1.0234	1.024536	1.023716
29	6 p. m		54 22 00	164 01 00	do	49	51	68	1.0234	1.024536	1.023716
29	12 p. m		54 18 00	163 18 00	do	50	51	68	1.0234	1.024536	1.023716
30	6 a. m		54 09 00	162 58 00	do	50	51	68	1.0234	1.024536	1.023716
30	12 m		54 08 00	162 43 30	do	50	51	68	1.0234	1.024536	1.023716
30	6 p. m		54 31 00	161 44 00	do	50	52	68	1.0234	1.024536	1.023716
30	12 p. m		54 42 00	161 13 00	do	49	51	68	1.0230	1.024136	1.023316
31	6 a. m		54 56 00	160 33 00	do	50	51	68	1.0230	1.024136	1.023316
31	1 p. m	Humboldt harbor			do	49	53	68	1.0226	1.083736	1.022916
Aug. 2	12 m	Eagle harbor			do	51	55	68	1.0230	1.024136	1.023316
3	12 m		54 44 00	161 27 30	do	51	52	68	1.0230	1.024136	1.023316
3	6 p. m		54 20 00	162 02 00	do	50	51	68	1.0230	1.024136	1.023316
3	12 p. m		54 18 00	161 34 00	do	51	52	68	1.0230	1.024136	1.023316
4	6 a. m		54 39 00	160 28 00	do	50	52	68	1.0230	1.024136	1.023316
4	12 m		54 56 00	159 54 00	do	50	51	71	1.0230	1.024606	1.023786
4	7 p. m	Yukon harbor			do	50	52	71	1.0230	1.024606	1.023786
5	12 m		54 50 00	159 08 00	do	52	52	71	1.0230	1.024606	1.023786
5	6 p. m		54 41 00	159 16 00	do	51	52	71	1.0230	1.024606	1.023786
5	12 p. m		54 34 00	159 40 00	do	50	50	71	1.0230	1.024606	1.023786
6	6 a. m		54 25 00	160 03 00	do	51	50	71	1.0230	1.024606	1.023786
6	12 m		54 34 00	158 43 00	do	51	58	71	1.0230	1.024606	1.023786
6	6 p. m		55 04 00	158 48 00	do	52	53	71	1.0230	1.024606	1.023786
6	12 p. m		55 20 00	158 48 00	do	51	51	71	1.0230	1.024606	1.023786
7	6 a. m		55 25 00	157 37 00	do	50	51	71	1.0230	1.024606	1.023786
7	12 m		55 45 00	158 25 00	do	51	52	71	1.0226	1.024206	1.023386
7	6 p. m	Ivanof Bay			do	51	55	71	1.0224	1.024006	1.023186
8	6 a. m	Off Mitrofania Island			do	50	53	71	1.0163	1.017906	1.017086
8	12 m		55 43 00	157 24 00	do	53	54	71	1.0226	1.024206	1.023386
8	6 p. m		55 37 00	156 57 00	do	51	54	71	1.0228	1.024406	1.023586
8	12 p. m		55 46 00	155 55 00	do	50	51	71	1.0230	1 024606	1.023786
9	6 a. m		55 44 00	155 14 00	do	48	50	71	1.0230	1.024606	1.023786
9	12 m		56 07 00	154 30 00	do	54	58	71	1.0230	1.024606	1.023786
9	6:30 p. m.		56 28 00	154 05 00	do	50	53	71	1.0230	1.024606	1.023786
9	12 p. m		56 23 00	153 24 00	do	51	53	71	1.0230	1.024606	1.023786
10	6 a. m		56 42 00	152 21 00	do	52	54	71	1.0230	1.024606	1.023786
10	12 m		57 00 00	153 20 30	do	56	58	71	1.0228	1.024406	1.023586
11	6 p. m	Old Harbor, Kadiak Island			do	58	73	71	1.0220	1.023606	4.022786
12	12 p. m		56 38 00	151 59 00	do	54	53	71	1.0234	1.025006	1.024186
13	6 a. m		57 03 00	152 10 00	do	52	53	70	1.0234	1.024850	1.024030
13	12 m		57 20 00	152 13 00	do	54	53	70	1.0234	1.024850	1.024030
13	6 p. m		57 11 00	151 05 00	do	53	55	70	1.0234	1.024850	1.024030
20	12 m	St. Paul, Kadiak			do	54	60	70	1.0230	1.024450	1.023630
21	6 p. m		57 52 00	151 47 00	do	55	56	70	1.0230	1.024450	1.023630
21	12 p. m		57 19 00	150 35 00	do	56	55	70	1.0230	1.024450	1.023630
22	6 a. m		57 44 00	150 46 00	do	52	54	70	1.0232	1.024650	1.023830
22	12 m		58 07 00	151 33 00	do	54	55	70	1.0230	1.024450	1.023630
22	6:30 p. m		58 05 00	150 46 00	do	56	62	70	1.0230	1.024450	1 023630
22	12 p. m		57 41 00	149 44 00	do	56	55	70	1.0230	1.024450	1.023630
23	6 a. m		58 05 00	149 48 00	do	55	59	70	1.0230	1.024450	1.023630
23	12 m		58 31 00	150 56 00	do	54	57	70	1.0228	1.024250	1.023430
23	6 p. m		58 51 00	150 47 00	do	56	55	70	1.0222	1.023650	1.022830
23	12 p. m		58 21 00	149 33 00	do	56	56	70	1.0226	1.024050	1.023230
24	6 a. m		57 54 00	148 34 00	do	56	57	70	1.0230	1.0 4450	1.023630
24	12 m		58 17 00	148 36 00	do	59	61	70	1.0226	1.024050	1.023230
24	6 p. m		58 46 00	149 17 00	do	56	57	69	1.0226	1.023887	1.023067
24	12 p. m		58 30 00	148 29 00	do	57	57	69	1.0226	1.023887	1.023067
25	6 a. m		58 37 00	147 50 00	do	58	59	69	1.0234	1.024687	1.023867
25	12 m		59 06 00	147 30 00	do	58	62	69	1.0234	1.024687	1.023867
25	6 p. m	Middleton Island			do	53	57	69	1.0226	1.023887	1.023067
26	2 p. m		59 01 00	144 22 00	do	53	59	69	1.0236	1.024887	1.024067
27	6 a. m		59 08 00	143 30 00	do	59	59	69	1.0236	1.024887	1.024067
27	12 m		59 09 00	142 51 00	do	60	64	69	1.0236	1.024887	1.024067
27	6 p. m		58 56 00	142 18 00	do	60	62	69	1.0234	1.024687	1.023867
27	12 p. m		58 27 00	141 11 00	do	59	60	69	1.0234	1.024687	1.023867
28	6 a. m		58 08 00	140 21 00	do	58	56	69	1.0232	1.024487	1.023667
28	12 m		57 44 00	139 30 00	do	58	56	69	1.0230	1.024287	1.023467

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1888, *to June* 30, 1889—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W	Depth.	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen when specific gravity was taken.	Observed specific gravity.	Specific gravity reduced to 60° F. with pure water at 60° F. as standard.	Specific gravity reduced to 15° C. with pure water at 4° C. as standard.
1888.			° ′ ″	° ′ ″	*Fms.*	°	°	°			
Aug. 28	6 p.m.		57 10 00	138 44 00	Surface.	58	58	69	1.0232	1.024487	1.023667
28	12 p.m.		56 36 00	137 58 00	do	58	58	69	1.0234	1.024687	1.023867
29	6 a.m.		56 02 00	137 11 00	do	57	57	69	1.0230	1.024287	1.023467
29	12 m.		55 28 00	136 25 00	do	59	60	69	1.0230	1.024287	1.023467
29	6 p.m.		54 56 00	135 47 00	do	60	65	69	1.0232	1.024487	1.023667
29	12 p.m.		54 23 00	135 09 00	do	57	57	69	1.0234	1.024687	1.023867
30	6 a.m.		53 52 00	134 31 00	do	57	57	69	1.0234	1.024687	1.023867
30	12 m.		53 18 00	133 55 00	do	57	59	69	1.0234	1.024687	1.023867
30	6:30 p.m.		52 48 00	133 04 00	do	60	79	69	1.0234	1.024687	1.523867
30	12 p.m.		52 22 00	132 11 00	do	58	59	69	1.0234	1.024687	1.023867
31	6 a.m.		51 54 00	131 21 00	do	59	59	69	1.0232	1.024487	1.023667
31	12 m.		51 24 00	130 29 00	do	59	65	69	1.0234	1.024687	1.023867
Sept. 5	6 p.m.	Burrows Bay			do	57	59	69	1.0214	1.022687	1.021867
6	12 m.		47 36 00	122 20 00	do	56	61	69	1.0216	1.022887	1.022067
7	High water.	Seattle, Wash			do	60	68	60	1.0192	1.019200	1.018380
7	Low water.	do			do	60	59	60	1.0152	1.015200	1.014380
17	4 p.m.	Port Townsend			do	54	59	69	1.0224	1.023687	1.022867
18	12 p.m.	Off Cape Flattery			do	51	52	69	1.0230	1.024287	1.023467
19	12 m.		48 00 00	126 02 00	do	59	61	69	1.0230	1.024287	1.023467
19	5 p.m.		47 55 00	126 29 00	do	59	61	69	1.0230	1.024287	1.023467
20	12 m.		48 08 00	125 02 00	do	59	59	69	1.0232	1.024487	1.023667
20	6 p.m.	Off Flattery Rocks			do	56	59	69	1.0232	1.024487	1.023667
20	12 p.m.		47 59 00	125 29 00	do	59	59	69	1.0234	1.024687	1.023867
21	6 a.m.		47 46 00	125 20 00	do	58	58	69	1.0230	1.024287	1.023467
21	12 m.		47 52 00	124 45 00	do	56	60	69	1.0226	1.023887	1.023067
21	6 p.m.		47 35 00	124 53 00	do	58	63	69	1.0228	1.024087	1.023267
21	12 p.m.		47 18 00	124 54 00	do	58	58	69	1.0230	1.024287	1.023467
22	6 a.m.		47 00 00	124 53 00	do	56	56	69	1.0230	1.024287	1.023467
22	12 m.		46 48 00	124 55 00	do	59	57	69	1.0230	1.024287	1.023467
22	12 p.m.		46 41 00	124 18 00	do	59	58	69	1.0220	1.023287	1.022467
23	6 a.m.		46 44 00	124 32 00	do	58	58	69	1.0230	1.024287	1.023467
23	12 m.		46 48 00	124 54 00	do	60	58	69	1.0230	1.024287	1.023467
24	6 p.m.	Neeah Bay, Wash			do	50	59	65	1.0244	1.025090	1.024270
27	12 m.	Barclay Sound, B. C			do	58	68	65	1.0192	1.019890	1.019070
Oct. 13	12 m.		46 08 00	124 45 00	do	62	62	65	1.0240	1.024690	1.023870
14	7 a.m.	Mouth Columbia River			do	56	56	65	1.0194	1.020090	1.019270
17	12 m.	Astoria, Oregon, high water			do	59	56	65	1.0054	1.006090	1.005270
18	3 p.m.	Tillamook Rock			do	60	62	65	1.0226	1.023290	1.022470
19	12 m.		43 59 00	125 03 00	do	58	60	65	1.0244	1.025090	1.024270
20	2 p.m.	Cape Mendocino			do	59	58	65	1.0250	1.025690	1.024870
1889.											
Jan. 3	6 p.m.	Pigeon Point Light, Cal			Surface	57	57	65	1.0252	1.025890	1.025070
3	12 p.m.	Monterey Bay, Cal			do	57	55	65	1.0254	1.026090	1.025270
4	6 a.m.	Off Point Sur, Cal			do	57	56	65	1.0254	1.026090	1.025270
4	12 m.		36 14 00	122 01 30	do	58	56	65	1.0254	1.026090	1.025270
4	6 p.m.	Off Piedra Blanca, Cal			do	58	56	65	1.0254	1.026090	1.025270
4	12 p.m.	North of Point Conception, Cal			do	57	56	65	1.0254	1.026090	1.025270
5	6 a.m.		34 25 00	120 42 00	do	57	56	65	1.0254	1.026090	1.025270
5	12 m.		34 12 00	120 32 00	do	60	62	65	1.0254	1.026090	1.025270
5	6 p.m.	San Miguel Island, Cal			do	59	60	65	1.0254	1.026090	1.025270
6	6 p.m.	Santa Rosa Island, Cal			do	58	60	65	1.0256	1.026290	1.025470
7	6 p.m.	Santa Barbara Channel			do	59	61	65	1.0256	1.026290	1.025470
8	6 p.m.		34 07 00	120 33 30	do	60	62	65	1.0256	1.026290	1.025470
8	12 m.		34 23 00	120 11 00	do	59	57	65	1.0254	1.026090	1.025270
8	6 p.m.	Santa Barbara Harbor, Cal			do	59	59	65	1.0254	1.026090	1.025270
9	6 p.m.	Off Point Hueneme, Cal			do	60	59	65	1.0254	1.026090	1.025270
9	12 p.m.	Off San Pedro Light, Cal			do	59	59	65	1.0254	1.026090	1.025270
10	6 a.m.	Off Point Loma, Cal			do	60	58	65	1.0254	1.026090	1.025270
12	2 p.m.	Alamitos Bay, Cal., No. 1			do	60	72	67	1.0212	1.022187	1.021367
12	2 p.m.	No. 2			do	60	72	67	1.0222	1.023187	1.022367
12	2 p.m.	No. 3			do	60	72	67	1.0206	1.021587	1.020767
12	2 p.m.	No. 4			do	60	72	66	1.0215	1.022340	1.021520
12	2 p.m.	No. 5			do	60	72	65	1.0152	1.015890	1.015070
12	2 p.m.	No. 6, mouth of river			do	60	72	64	1.0114	1.011948	1.011128
13	3 p.m.	Newport Bay, Cal., No. 1			do	60	70	60	1.0240	1.024000	1.023180

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, from July 1, 1888, *to June* 30, 1889.—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen when specific gravity was taken.	Observed specific gravity.	Specific gravity reduced to 60° F. with pure water at 60° F. as standard.	Specific gravity reduced to 15° C. with pure water at 4° C. as standard.
1889.			° ′ ″	° ′ ″	*Fms.*	°F	°F	°F			
13	3 p. m	Medium high water No. 2			Surface	60	70	60	1.0240	1.024000	1.023180
Jan. 13	3 p. m	Low water No. 2			...do...	60	70	60	1.0154	1.015400	1.014580
13	3 p. m	Newport Bay, Cal., No. 3			...do...	60	70	60	1.0230	1.023000	1.022180
13	3 p. m	Newport Bay, Cal., No. 4			...do...	60	70	60	1.0240	1.024000	1.023180
15	12 m	San Diego Harbor, Cal			...do...	58	57	66	1.0252	1.026040	1.025220
15	6 p. m	Off Point Loma, Cal			...do...	58	57	66	1.0252	1.026040	1.025220
15	12 p. m		32 32 00	118 07 00	...do...	58	57	66	1.0256	1.026440	1.025620
16	6 a. m		32 29 00	118 42 00	...do...	59	56	66	1.0254	1.026240	1.025420
16	12 m		32 25 00	119 03 30	...do...	60	60	66	1.0254	1.026240	1.025420
16	12 p. m		32 21 00	119 15 00	...do...	58	57	66	1.0254	1.026240	1.025420
17	6 a. m		32 17 00	119 17 00	...do...	58	55	66	1.0254	1.026240	1.025420
17	12 p. m		32 59 00	119 14 00	...do...	58	56	66	1.0254	1.026240	1.025420
18	12 m	San Nicolas Island, Cal			...do...	58	56	66	1.0254	1.026240	1.025420
18	6 p. m	Off Santa Catalina Island, Cal			...do...	59	59	66	1.0254	1.026240	1.025420
18	11:25 p. m		33 03 00	118 12 30	...do...	58	56	66	1.0254	1.026240	1.025420
24	6 p. m		32 39 30	119 07 45	...do...	59	61	66	1.0252	1.026040	1.025220
25	12 m	San Clemente Island, Cal			...do...	59	59	66	1.0252	1.026040	1.025220
26	2 p. m	Roseville, San Diego Bay, Cal			...do...	60	69	66	1.0250	1.025840	1.025020
Feb. 5	12 m	Off Point Firmin, Cal			...do...	58	56	77	1.0240	1.026618	1.025798
6	12 m	Santa Cruz Island, Cal			...do...	59	58	77	1.0240	1.026618	1.025798
13	4 p. m	Santa Barbara Island, Cal			...do...	58	58	77	1.0240	1.026618	1.025798
14	10 a. m	Santa Catalina Island, Cal			...do...	59	58	77	1.0240	1.026618	1.025798
26	6 p. m		32 05 45	117 23 15	...do...	59	63	77	1.0238	1.026418	1.025598
26	12 p. m		31 29 30	117 33 00	...do...	59	60	77	1.0238	1.026418	1.025598
27	7 a. m		30 21 00	117 51 30	...do...	60	60	77	1.0238	1.026418	1.025598
27	12 m		29 54 30	117 58 30	...do...	62	62	77	1.0237	1.026318	1.025498
27	6 p. m	Guadaloupe Island, Lower Cal			...do...	61	63	77	1.0237	1.026318	1.025498
28	3 a. m		27 46 30	117 36 00	...do...	62	60	77	1.0238	1.026418	1.025598
Mar. 1	6 a. m		27 40 30	117 30 00	...do...	62	60	77	1.0236	1.026218	1.025398
1	12 m		26 58 00	117 02 00	...do...	63	65	77	1.0238	1.026418	1.025598
1	6 p. m		26 12 00	116 37 00	...do...	65	75	77	1.0240	1.026618	1.025798
2	6. a. m		25 15 00	116 00 00	...do...	64	64	77	1.0238	1.026418	1.025598
2	12 m		24 51 00	115 43 00	...do...	65	65	77	1.0238	1.026418	1.025598
2	8 p. m		23 52 00	115 35 00	...do...	67	65	77	1.0240	1.026618	1.025798
2	12 p. m		23 02 00	115 24 00	...do...	66	65	77	1.0240	1.026618	1.025798
3	8 a. m		22 20 00	115 17 00	...do...	68	66	77	1.0240	1.026618	1.025798
3	12 m		21 52 00	115 11 00	...do...	69	69	77	1.0242	1.026818	1.025998
3	6 p. m		20 47 00	115 03 00	...do...	69	69	77	1.0242	1.026818	1.025998
3	12 p. m		20 02 00	114 57 00	...do...	70	68	77	1.0242	1.027018	1.026198
4	6 a. m		19 35 00	114 52 00	...do...	69	67	77	1.0242	1.026818	1.025998
4	12 m		18 42 00	114 45 00	...do...	70	70	77	1.0244	1.027018	1.026198
5	12 m	Clarion Island			...do...	71	71	77	1.0244	1.027018	1.026198
6	12 p. m		18 25 30	113 48 00	...do...	71	70	77	1.0240	1.026618	1.025798
7	6 a. m		18 24 30	113 15 00	...do...	72	69	77	1.0240	1.026618	1.025798
7	12 m		18 27 00	112 24 00	...do...	74	74	77	1.0242	1.026818	1.025998
7	6 p. m		18 32 00	111 41 00	...do...	72	70	77	1.0242	1.026818	1.025998
9	12 m	Socorro Island			...do...	73	73	77	1.0242	1.026818	1.025998
10	12 m	San Benedicto Island			...do...	73	73	77	1.0242	1.026818	1.025998
10	8 p. m		19 40 15	110 41 15	...do...	73	72	77	1.0242	1.026818	1.025998
10	11 p. m		20 09 00	110 32 30	...do...	68	68	77	1.0242	1.026818	1.025988
11	6 a. m		20 55 15	110 18 30	...do...	70	70	77	1.0242	1.026818	1.025998
11	12 m		21 44 18	110 03 30	...do...	74	72	77	1.0242	1.026818	1.025998
11	6 p. m		22 25 30	109 42 15	...do...	71	69	77	1.0242	1.026818	1.025998
12	12 m	Pichilinque Bay, Lower California.			...do...	72	69	75	1.0250	1.027265	1.026445
16	12 m		34 31 00	110 29 15	...do...	72	74	75	1.0250	1.027265	1.026445
16	6 p. m	San Josef Island, Gulf of California.			...do...	72	72	75	1.0250	1.027265	1.026445
17	8 a. m	Lagoon, San Josef Island			...do...	71	75	72	1.0260	1.027764	1.026944
17	12 m		25 23 48	110 50 00	...do...	69	69	75	1.0250	1.027265	1.026445
18	12 m	Carmen Island, Gulf of California.			...do...	67	70	75	1.0250	1.027265	1.026445
18	6 p. m	Carmen Island, Lobos Point, Gulf of California.			...do...	68	69	75	1.0250	1.027265	1.026445
19	12 p. m	Off Conception Bay, Gulf of California.			...do...	67	69	75	1.0250	1.027265	1.026445

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, from July 1, 1888, to June 30, 1889—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen when specific gravity was taken.	Observed specific gravity.	Specific gravity reduced to 60° F. with pure water at 60° F. as standard.	Specific gravity reduced to 15° C. with pure water at 4° C. as standard.
1889.			° ′ ″	° ′ ″	*Fms.*	°F.	°F.	°F.			
Mar. 19	12 m.....	Conception Bay, Gulf of California.			Surface.	69	72	75	1.0252	1.027465	1.026645
19	6 p. m...	Mouth Mulege River, Gulf of California			..do ...	67	70	75	1.0240	1.026265	1.025445
20	5 a. m...	3009	27 09 00	111 42 00	. do ...	66	66	73	1.0254	1.027324	1.026504
20	5 a. m...	3009	27 09 00	111 42 00	50	60	66	73	1.0254	1.027324	1.026504
20	5 a. m..	3009	27 09 00	111 42 00	100	58	66	73	1.0252	1.027124	1.026304
20	5 a. m..	3009	27 09 00	111 42 00	200	51.6	66	70	1.0260	1.027450	1.026630
20	5 a. m...	3009	27 09 00	111 42 00	300	44.7	66	72	1.0256	1.027364	1.026544
20	5 a. m...	3009	27 09 00	111 42 00	400	42.6	66	71	1.0252	1.026806	1.025986
20	5 a. m..	3009	27 09 00	111 42 00	500	40.9	66	71	1.0250	1.026606	1.025786
20	5 a. m...	3009	27 09 00	111 42 00	600	0	66	70	1.0252	1.026650	1.025830
20	5 a. m...	3009	27 09 00	111 42 00	700	39.2	66	71	1.0250	1.026606	1.025786
20	11 a. m..	3010	27 23 45	111 25 00	Surface	71	74	72	1.0256	1.027364	1.026544
20	11 a. m...	3010	27 23 45	111 25 00	50	63.7	74	72	1.0256	1.027364	1.026544
20	11 a. m...	3010	27 23 45	111 25 00	100	56.7	74	72	1.0254	1.027164	1.026344
20	11 a. m...	3010	27 23 45	111 25 00	200	49.9	74	72	1.0252	1.026964	1.026144
20	11 a. m...	3010	27 23 45	111 25 00	300	46.2	74	72	1.0250	1.026764	1.025944
20	11 a. m...	3010	27 23 45	111 25 00	400	43.2	74	72	1.0250	1.026764	1.025944
20	11 a. m...	3010	27 23 45	111 25 00	500	0	74	72	1.0250	1.026764	1.025944
20	11 a. m..	3010	27 23 45	111 25 00	600	0	74	72	1.0250	1.026764	1.025944
20	11 a. m...	3010	27 23 45	111 25 00	700	0	74	72	1.0250	1.026764	1.025944
20	11 a. m...	3010	27 23 45	111 25 00	800	0	74	72	1.0250	1.026764	1.025944
20	11 a. m...	3010	27 23 45	111 25 00	900	37.8	74	72	1.0252	1.026964	1.026144
20	7 p. m ..	Hyd. 1830	27 37 15	111 09 00	Surface	66	70	71	1.0258	1.027406	1.026586
20	7 p. m ..	Hyd. 1830	27 37 15	111 09 00	50	63.6	70	71	1.0256	1.027206	1.026386
20	7 p. m..	Hyd. 1830	27 37 15	111 09 00	100	57.7	70	71	1.0254	1.027006	1.026186
20	7 p. m	Hyd. 1830	27 37 15	111 09 00	200	0	70	71	1.0254	1.027006	1.026186
20	7 p. m...	Hyd. 1830	27 37 15	111 09 00	300	45.8	70	71	1.0252	1.026806	1.025986
20	7 p. m..	Hyd. 1830	27 37 15	111 09 00	400	43.2	70	71	1.0252	1.026806	1.025986
20	7 p. m ..	Hyd. 1830	27 37 15	111 09 00	500	41	70	71	1.0252	1.026806	1.025986
22	12 m ...	Guaymas, Mexico	......	...	Surface	70	70	73	1.0260	1.027924	1.027104
23	4.36 p. m.	3012	28 16 00	111 54 00	...do ...	69	67	73	1.0256	1.027524	1.026704
23	4 36 p. m.	3012	28 16 00	111 54 00	22	63	67	73	1.0252	1.027124	1.026304
23	7:35 p. m	3014	28 28 00	112 04 30	Surface	66	68	73	1.0254	1.027324	1.026504
23	7:35 p. m.	3014	28 28 00	112 04 30	29	62.9	68	73	1.0252	1.027124	1.026304
24	12:24 a. m.	Hyd. 1831	28 44 15	112 32 15	Surface	61	64	73	1.0252	1.027124	1.026304
24	12:24 a. m.	Hyd. 1831	28 44 15	112 32 15	89	61.2	64	73	1.0252	1.027124	1.026304
24	5:50 a. m.	3015	29 19 00	112 50 00	Surface	63	64	73	1.0254	1.027324	1.026504
24	5.50 a. m	3015	29 19 00	112 50 00	72	59	64	73	1.0252	1.027124	1.026304
24	5:50 a. m.	3015	29 19 00	112 50 00	115	54.9	64	73	1.0252	1.027124	1.026304
24	9:01 a. m	3016	29 40 00	112 57 00	Surface	65	70	72	1.0254	1.027164	1.026344
24	9.01 a. m.	3016	29 40 00	112 57 00	76	56	70	72	1.0252	1.026964	1.026144
24	11:19 a. m.	3017	29 54 30	113 01 00	Surface	67	72	72	1.0254	1.027164	1.026344
24	11:19 a. m.	3017	29 54 30	113 01 00	58	61.8	72	72	1.0252	1.026964	1.026144
24	2:21 p. m	3018	30 16 00	113 05 00	Surface	66	72	72	1.0254	1.027164	1.026344
24	2:21 p. m	3018	30 16 00	113 05 00	36	63.3	72	72	1.0252	1.026964	1.026144
24	4:09 p. m.	3019	30 28 00	113 06 30	Surface	66	67	72	1.0254	1.027164	1.026344
24	4:09 p. m.	3019	30 28 00	113 06 30	14	66	67	72	1.0252	1.026964	1.026144
24	7:25 p. m.	3021	30 47 00	113 13 00	Surface	65	67	72	1.0254	1.027164	1.026344
24	7:25 p. m.	3021	30 47 00	113 13 00	14	.	67	72	1.0252	1.026964	1.026144
24	9 p. m...	3022	30 58 30	113 17 15	Surface	66	66	72	1.0254	1.027164	1.026344
24	9 p. m..	3022	30 58 30	113 17 15	14	66	66	72	1.0252	1.026964	1.026144
25	12 m ...	....	31 16 00	113 29 00	Surface	67	69	70	1.0260	1.027450	1.026630
25	5.42 p. m.	3024	31 21 00	113 49 00	do	67	68	70	1.0260	1.027450	1.026630
25	5.42 p. m.	3024	31 21 00	113 49 00	11	67	68	70	1.0258	1.027250	1.026430
25	7.16 p. m	3025	31 21 15	113 59 00	Surface	67	67	70	1.0260	1.027450	1.026630
25	7 16 p. m.	3025	31 21 15	113 59 00	9	66.1	67	70	1.0258	1.027250	1.026430
25	8 32 p. m.	3026	31 22 00	114 07 45	Surface	66	67	70	1.0258	1.027250	1.026430
25	8 32 p. m.	2026	31 22 00	114 07 45	17	66	67	70	1.0256	1.027050	1.026230
26	10 a. m. .	Shoal Point, Colorado River Gulf of California.			Surface	66	64	67	1.0262	1.027187	1.026367
26	5 p. m	Shoal Point, Colorado River			do	68	70	69	1.0260	1.027287	1.026467
27	4 40 a. m.	Hyd. 1832	31 23 00	114 25 00	do	65	66	76	1.0252	1.027642	1.026822
27	4 40 a. m.	Hyd. 1832	31 23 00	114 25 00	10	65	66	76	1.0252	1.027642	1.026822
27	6 a. m	1833	31 13 30	114 27 15	Surface	64	66	76	1.0252	1.027682	1.026862
27	6 a. m	1833	31 13 30	114 27 15	18	64	66	76	1.0250	1.027442	1.026622

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, from July 1, 1888, *to June* 30, 1889—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen at time specific gravity was taken.	Observed specific gravity.	Specific gravity reduced to 60° F. with pure water at 60° as standard.	Specific gravity reduced to 15° C. with pure water at 4° C. as standard.
1889.			° ′ ″	° ′ ″	*Fms.*	°F.	°F.	°F.			
Mar. 27	7:10 a. m.	3030	31 07 00	114 29 00	Surface	65	66	76	1.0252	1.027642	1.026822
27	7:10 a. m.	3030	31 07 00	114 29 00	20	64	66	74	1.0254	1.027486	1.026666
27	10:17 a. m	3033	30 50 45	114 29 40	Surface	65	67	74	1.0254	1.027486	1.026666
27	10:17 a. m	3033	30 50 45	114 29 40	18	63.5	67	74	1.0252	1.027286	1.026466
27	12:30 p. m.	3034	30 36 30	114 27 45	Surface	69	67	74	1.0254	1.027486	1.026666
27	12:30 p. m.	3034	30 36 30	114 27 45	24	63.5	67	74	1.0252	1.027286	1.026466
27	2:30 p. m.	3035	30 21 00	114 25 15	Surface	70	70	74	1.0254	1.027486	1.026666
27	2:30 p. m.	3035	30 21 00	114 25 15	30	62	70	74	1.0252	1.027286	1.026466
28	12 m	Gonzales Bay, Gulf of California			Surface	68	68	78	1.0244	1.027208	1.026388
29	4 p. m ...	Refuge Harbor, Angel I., Cal. .			...do ...	69	77	78	1.0244	1.027208	1.026388
31	9:40 a. m.	3037	27 45 00	110 45 00	...do ...	69	72	78	1.0242	1.027208	1.026388
31	9:40 a. m	3037	27 45 00	110 45 00	20	65.2	77	78	1.0242	1.027208	1.026388
31	10 a. m ...	Upper Algodones Lagoon, Mex			Surface	69	72	78	1.0237	1.026508	1.025688
31	6 p. m ...	Lower Algodones Lagoon, Mex.			...do ...	72	72	78	1.0200	1.022808	1.021988
Apr. 1	2 p. m ...	Mouth Yaqui River, Mex			...do ...	74	72	60	1.000	1.000000	.999180
1	3 p. m ...	4 miles up the river, Mex.......			...do ...	74	73	60	1.000	1.000000	.999180
1	5 p. m ...	Ship's anchorage 3 miles from shore.			...do ...	73	74	78	1.0040	1.006808	1.005988
1	6 p. m ...	Off Yaqui River, Mex.........			...do ...	71	73	78	1.0242	1.027008	1.026188
2	12 m ...	Off San Juan Lagoon, Mex.....			...do ...	70	73	78	1.0240	1.026808	1.025988
2	6 p. m ...	Off Fuerte River, Mex.........			...do ...	76	82	78	1.0240	1.026808	1.025988
2	12 p. m ...	....	25 05 00	109 57 00	...do ...	71	72	78	1.0244	1.027208	1.026388
7	12 m	San Juan Harbor, Lower Cal...			...do ...	75	75	67	1.0260	1.026987	1.026167
9	12 m	Magdalena Bay, Lower Cal.....			...do ...	67	68	67	1.0260	1.026987	1.026167
9	2:17 p. m.	30 40	24 35 00	112 04 30	...do ...	69	68	67	1.0260	1.026987	1.026167
9	2:17 p. m.	30 40	24 35 00	112 04 30	21	69	68	67	1.0254	1.026387	1.025567
9	2:38 p. m.	30 41	24 35 30	112 05 00	Surface	69	68	67	1.0260	1.026987	1.026167
9	2:38 p. m.	30 41	24 35 30	112 05 00	27	69	68	67	1.0254	1.026387	1.025567
9	12 p. m ...	....	24 57 00	112 33 00	Surface	65	64	67	1.0260	1.026987	1.026167
10	12 m	....	26 07 00	113 33 30	...do ...	65	65	67	1.0254	1.026387	1.025567
11	12 m	San Bartolme Bay, Lower Cal..			...do ...	63	63	67	1.0254	1.026387	1.025567
12	2 p. m ..	Cerros Island, Lower Cal			...do ...	65	65	67	1.0254	1.026387	1.025567
13	12 m	San Quentin Bay, Lower Cal...			...do ...	59	61	67	1.0250	1.02 987	1.025167
May 21	2 p. m ..	Golden Gate, Cal			...do ...	56	57	66	1.0244	1.025240	1.024420
22	10 p. m ...	Cape Mendocino, Cal...........			...do ...	51	53	66	1.0250	1.025840	1.025020
23	2 p. m ...	Cape Blanco, Oregon...........			...do ...	55	55	66	1.0250	1.025840	1.025020
24	12 m	Mouth Columbia River, Oregon			...do ...	60	67	66	1.0114	1.012240	1.011420
25	1 a. m ...	Cape Flattery, Wash			...do ...	55	57	66	1.0234	1.024240	1.023420
25	1 p. m ..	Mouth Frazier River, B. C			...do ...	62	60	66	1.0020	1.002840	1.002020
26	10 p. m ...	Active Pass, B. C			...do ...	60	62	66	1.0100	1.010840	1.010020
June 7	12 m	....	46 45 00	124 36 00	...do ...	57	56	66	1.0236	1.024440	1.023620
8	12 m	....	44 00 00	124 57 00	...do ...	56	57	66	1.0238	1.024640	1.023820
9	12 m	Yakima Light-house, Oregon...			...do ...	53	56	66	1.0250	1.025840	1.025020
18	8 p. m ...	Port Orchard, Wash			...do ...	56	66	66	1.0220	1.022840	1.022020
28	12 m	....	47 30 00	125 40 00	...do ...	56	56	66	1.0236	1.024440	1.023620
29	12 m	....	47 22 00	125 35 00	...do ...	57	57	66	1.0236	1.024440	1.023620

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1 to December 31, 1888.

Date.	Position at meridian.		Temperatures—Fahrenheit.									Barometer.			Weather.	Clear sky in tenths.	Wind.		Rain.
			Air, dry bulb.			Air, wet bulb.			Water at surface.										
	Lat. N.	Long. W.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.			Direction.	Force.	
1888.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°	°								
July 1	San Francisco		71	54	62.5	65	59	59	63	58	60.5	30.14	29.98	30.06	Clear	6–9	SW	0–35	0
2	...do		73	57	65	67	57	62	66	59	62.5	29.98	29.84	29.91	...do	7–9	SW. and WSW	1–2	0
3	...do		70	57	63.5	65	57	61	62	58	60	30.02	29.90	29.96	...do	8–9	SW	0–4	0
4	37 54 00	122 40 30	71	52	61.5	65	52	58.5	63	49	56	30.04	29.96	30.00	Fair	2–9	SW., NNW., WNW.	1–4	0
5	40 18 00	124 28 00	55	51	53	54	52	53	53	48	50.5	30.06	29.98	30.02	...do	7–9	WNW., NW., NW. by N.	2–7	0
6	42 29 00	129 34 00	55	55	55	55	50	51.5	52	48	50	30.10	30.00	30.05	...do	8–9	NNW., NW., N	4–7	0
7	45 04 00	124 04 00	62	53	57.5	60	54	57	59	47	53	30.08	29.98	30.03	do	5–9	N., NW., W	1–6	0
8	48 09 00	124 57 00	63	58	60.5	60	57	58.5	60	52	55.5	30.08	29.92	30.00	Overcast to fair	0–9	W., NW., NNW., SW	1–4	0
9	Esquimalt		61	54	57.5	60	54	57	65	51	55.5	30.16	29.98	30.07	Fair	0–8	SW., SE., SSE	0–6	Light.
10	Departure Bay		69	50	59.5	68	50	59	66	53	58.5	30.16	30.08	30.12	...do	5–9	ESE., E	0–2	0
11	...do		69	52	60.5	67	50	58.5	66	58	62	30.18	29.94	30.06	Clear	6–9	E., NE		0
12			58	56	57	57	55	56	60	50	55	30.16	29.94	30.05	Overcast to fair	0–8	SSW. to NW		Light.
13	Beaver Harbor		56	53	54.5	55	53	54	56	52	54	30.30	30.14	30.22	Overcast to cloudy	0–4	SW. to ENE		Light.
14	51 19 00	132 26 00	55	54	54.5	55	53	54	56	54	55	30.34	30.26	30.30	Overcast, fog	0–3	SW. by S. to SE. by S		Mod.
15	52 15 00	137 13 30	54	53	53.5	54	53	53.5	54	52	53	30.40	30.28	30.34	Overcast	0–3	SSW. to SE		Light.
16	52 35 00	142 34 00	53	49	51	53	50	51.5	52	51	51.5	30.30	30.20	30.25	Fog to fair	0–8	SW. to SE		Light.
17	52 35 00	147 14 00	51	48	49.5	50	49	49.5	51	50	50.5	30.40	30.30	30.35	Overcast	0–7	SW		Light.
18	51 58 00	152 12 00	52	49	50.5	52	48	50	51	50	50.5	30.40	30.26	30.33	Overcast to fair	0–5	S. by W., to ESE		Light.
19	52 11 00	157 44 00	51	50	50.5	51	49	50	51	48	49.5	30.24	30.16	30.20	Fog	0	SE. to NW		Light.
20	52 25 00	162 40 00	55	50	52.5	55	50	52.5	51	49	50	30.22	30.14	30.18	Fog to cloudy	0–2	NNW. to ESE		Light.
21	52 50 00	166 42 00	54	51	52.5	53	51	52	51	48	49.5	30.26	30.22	30.24	Fog	0	E. to SSW		Light.
22	53 40 00	164 28 50	52	50	51	52	50	51	50	48	49	30.30	30.20	30.25	do	0	SSE., SE., ESE., E		Light.
23	54 10 00	166 13 00	58	48	53	57	48	52.5	52	45	48.5	30.20	29.90	30.05	Foggy to fair	0–4	ESE., ENE., SE		Light.
24	Iliuliuk		58	54	56	56	53	54.5	53	52	52.5	29.90	29.80	29.85	Fog, cloudy, and misty.	0–4	SE., ENE., ESE		Light.
25	...do		59	50	54.5	56	49	52.5	56	51	53.5	30.00	29.86	29.93	Foggy	0–3	SE	1–5	Light.
26	...do		57	50	53.5	55	49	52	51	49	50	30.00	29.88	29.94	Overcast; fair	0–7	SE., NNW	0–2	0
27	...do		55	50	52.5	54	50	52	51	49	50	30.00	29.80	29.90	Fog	0	NE	0–2	Light.
28	53 56 00	166 07 00	52	48	50	52	47	49.5	52	47	49.5	29.80	29.72	29.79	...do	0	NE	0–2	Light.
29	54 11 00	164 46 00	53	50	51.5	52	50	51	52	49	50.5	29.90	29.86	29.88	...do	0	NE. to SW	1–4	Mod.
30	54 08 00	162 43 30	52	50	51	51	50	50.5	50	49	49.5	29.86	29.79	29.82	...do	0	SE	3–4	Light.
31	55 17 00	160 31 00	53	51	52	53	51	52	51	49	50	29.86	29.72	29.79	...do	0	S. to SE	2–4	Mod.
Aug. 1	55 20 00	160 32 00	55	52	53.5	55	52	52.5	51	50	50.5	29.90	29.78	29.84	...do	0–4	SE. and SSE	2	Light.
2	55 07 00	160 04 30	59	51	55	58	51	54.5	51	49	50	30.18	29.76	29.92	Fog; fair	0–7	SE. to NW	0–4	Light.
3	54 44 00	161 27 30	56	50	53	55	49	52	51	49	50	30.24	30.10	30.17	Fair; foggy	7–0	SE. ESE	0–3	Light.

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1 to December 31, 1888—Continued.

Date.	Position at meridian. Lat. N.	Position at meridian. Long. W.	Air, dry bulb. Maximum.	Air, dry bulb. Minimum.	Air, dry bulb. Mean.	Air, wet bulb. Maximum.	Air, wet bulb. Minimum.	Air, wet bulb. Mean.	Water at surface. Maximum.	Water at surface. Minimum.	Water at surface. Mean.	Barometer. Maximum.	Barometer. Minimum.	Barometer. Mean.	Weather.	Clear sky in tenths.	Wind. Direction.	Wind. Force.	Rain.
1888.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°	°								
Aug. 4	54 56 00	159 54 00	53	51	52	53	49	51	51	47	49	30.30	30.10	30.20	Fog; fair	0–5	SW	3–5	Light.
5	54 50 00	159 08 00	54	50	52	53	49	51	52	48	50	30.50	30.30	30.40	Fair	9–1	SE. to SW	1–4	Light.
6	54 34 00	158 43 00	58	50	54	56	50	53	53	50	51.5	30.54	30.50	30.52	Overcast; fair	0–7	SSW	2–3	0
7	55 45 00	158 25 00	55	50	52.5	54	49	51.5	52	50	51	30.50	30.38	30.44	Fair	0–6	SSW	1–3	0
8	55 43 00	157 24 00	57	53	55	56	52	54	53	50	51.5	30.38	30.30	30.34	Fog	0	SSW	0–3	Light.
9	56 07 00	154 39 00	58	50	54	57	50	53.5	54	48	51	30.30	30.26	30.28	Fog; fair	0–9	WSW	1–3	Light.
10	57 00 00	153 20 30	73	52	61.5	73	51	61	58	51	54.5	30.32	30.24	30.28	Clear	7–9	SW., WSW	0–3	0
11	57 01 00	155 12 00	67	51	59	66	51	58	60	51	55.5	30.42	30.32	30.37	do	6–10	SSW	0–2	0
12	Old Harbor, Kadiak.		60	52	56	59	52	55.5	56	53	54.5	30.58	30.44	30.51	Fog; fair	0–9	SW	0–4	Light.
13	57 20 00	152 13 00	57	51	54	56	50	53	54	49	51.5	30.56	30.48	30.52	do	0–9	SW	3–4	Light.
14	St. Paul, Kadiak		63	51	57	60	53	56.5	55	49	52	30.48	30.32	30.40	Fog; clear	0–10	SW	0–3	0
15	do		69	51	60	66	51	58.5	55	49	52	30.32	30.10	30.21	Fair	4–9	SW	0–2	0
16	do		57	53	55	57	52	54.5	53	51	52	30.10	29.84	29.97	Fair; fog	8–0	NE. to SE	0–2	Light.
17	do		63	52	57.5	59	50	54.5	54	50	52	29.80	29.58	29.69	Foggy to fair	0–6	ESE. to ENE	1–2	Light.
18	do		57	54	55.5	56	54	55	52	51	51.5	29.64	29.58	29.61	Fog	0	N	2–4	Light.
19	do		60	53	56.5	57	52	54.5	54	51	52.5	29.90	29.64	29.77	Fog to fair	0–6	N	1–2	Light.
20	do		61	53	57	60	52	56	54	51	52.5	30.00	29.90	29.95	Fair	2–8	N. to NE	0–2	0
21	do		61	51	56	60	51	55.5	54	50	52	30.06	30.00	30.03	Fair to overcast	9–0	N. to NE. by E	0–3	0
22	58 07 00	151 33 00	68	54	61	63	53	58	57	52	54.5	30.14	30.04	30.09	Fair	2–9	N. to WSW	0–3	0
23	58 31 00	150 56 00	64	55	59.5	60	54	57	56	53	54.5	30.18	30.12	30.15	Fair to overcast	9–0	Variable	0–2	0
24	58 17 00	148 36 00	62	56	59	59	56	57.5	59	56	57.5	30.20	30.16	30.18	Fair	3–9	N. to E	0–3	0
25	59 06 00	147 30 00	64	54	59	61	54	57.5	59	53	56	30.16	29.70	29.93	Overcast to fair	0–9	ENE., N. to WNW	0–4	Light.
26	Middleton Island		61	54	57.5	59	54	56.5	58	52	55	29.72	29.56	29.64	Fair	5–9	Variable	2–4	0
27	59 09 00	142 51 00	66	59	62.5	66	58	62	60	58	59	29.72	29.60	29.66	Fair to overcast	7–0	Variable	2–3	Light.
28	57 44 00	139 30 00	60	56	58	60	55	57.5	60	58	59	30.16	29.66	29.91	Overcast to fair	0–9	W., S. to ESE	0–3	Mod.
29	55 28 00	136 25 00	65	57	61	65	56	60.5	60	56	58	30.30	30.18	30.24	Fair	4–9	Variable	0–2	0
30	53 18 00	133 55 00	79	56	67.5	70	56	64	60	57	58.5	30.22	30.10	30.16	Overcast to fair	0–9	NNW., SW	1–4	0
31	51 24 00	130 29 00	79	59	69	72	59	65.5	60	55	57.5	30.26	30.12	30.19	Clear; foggy	9–0	N. to WSW	0–2	0
Sept. 1	50 50 00	127 43 00	67	54	60.5	65	53	57	60	52	56	30.28	30.12	30.20	Fog; fair	0-7-9	NE. to WSW	0–3	Light.
2	50 15 00	125 25 00	79	52	65.5	73	52	62.5	69	50	59.5	30.14	29.96	30.05	Fog; clear	0–10	W. to E	0–2	0
3	Departure Bay		70	62	66	66	61	63.5	67	60	63.5	30.00	29.86	29.93	Clear to fair	10–2	SW., E., NE	0–3	0
4	do		64	59	61.5	63	59	61	64	59	61.5	30.08	29.98	30.03	Overcast to fair	0–8	NE. E	0–2	Mod.
5	48 57 00		60	55	57.5	59	55	57	62	53	57.5	30.24	30.08	30.16	Fair; overcast	8–0	E. to SSE	0–3	Light.
6	Seattle, Wash		70	58	64	68	57	62.5	64	52	58	30.34	30.24	30.29	Overcast; fair	0–8	Variable	0–2	0
7	do		68	58	63	65	57	61	61	54	57.5	30.32	30.12	30.22	Clear	8–10	N., W	0–3	0

	8	... do		68	55	61.5	66	55	60.5	62	56	59	30.20	30.04	30.12	Clear; foggy; fair	10 0-8	W	0—1	0
	9	... do		64	57	60.5	64	56	60	61	56	58.5	30.18	30.12	30.15	Foggy; clear	0-10	S., SW	0—1	0
	10	... do		73	51	62	65	52	58.5	60	55	57.5	30.16	29.92	30.04	Clear	9-10	N., W	0—4	0
	11	... do		72	51	61.5	67	51	59	62	56	59	29.96	29.82	29.89	Fair; fog	9—0	SE., W	0—2	0
	12	... do		70	54	62	67	54	60.5	60	57	58.5	30.04	29.88	29.96	... do	9—0	SE. to W., SW	0—2	Light.
	13	... do		67	58	62.5	65	57	61.1	64	56	60	30.26	30.06	30.16	Misty to clear	0—9	Variable	0—4	Light.
	14	... do		76	55	65.5	70	55	62.5	61	55	58	30.16	29.86	30.01	Clear	10	NW., WSW., W	0—3	0
	15	... do		65	59	62	63	59	61	61	55	58	30.00	29.84	29.92	Foggy	0	W., WSW	0—2	0
	16	... do		66	59	62.5	65	58	61.5	59	56	57.5	29.95	29.90	29.93	Foggy and misty	0—4	E. to S	0—2	Light.
	17	47 43 00	122 26 00	64	54	59	61	54	57.5	58	50	54	30.16	29.96	30.06	Squally to clear	0—9	S. to NNW	0—4	Light.
	18	Port Townsend		60	51	55.5	58	51	54.5	54	50	52	30.30	30.08	30.19	Clear, fair; misty	10-7-0	SSE., NE., N., SSW., SW	0—1	0
	19	48 09 00	125 02 00	62	53	57.5	62	53	57.5	61	52	56.5	30.06	29.82	29.94	Squally and misty	0—2	ENE., ESE., SSE., S	2—6	Light.
	20	48 08 00	125 02 00	60	56	58	61	55	58	59	52	55.5	30.02	29.84	29.93	Squally	0—7	SE. by E. to S	2—5	Light.
	21	47 52 00	124 45 00	63	58	60.5	62	58	60	59	56	57.5	30.34	30.02	30.18	Fair to clear	5—9	Variable	1—3	Light.
	22	46 48 00	124 55 00	60	56	58	59	55	57	60	56	58	30.40	30.32	30.36	Clear to fair	10—7	NNW. to NNE	2—4	0
	23	46 48 00	124 54 00	63	57	60	62	57	59.5	62	58	60	30.50	30.42	30.46	Clear	8—10	WNW. to NE	2—4	0
	24	48 27 00	124 56 00	63	55	59	59	55	57	58	50	54	30.50	30.36	30.43	... do	8—10	NW. by N. to ENE	1—4	0
	25	48 33 00	125 14 00	67	55	61	63	54	58.5	59	49	54	30.34	30.14	30.24	Clear	10	WNW. to E	0—3	0
	26	49 00 00	125 48 00	74	56	65	68	56	62	62	54	58	30.14	30.02	30.08	... do	10	N. to ESE	0—1	0
	27	Barclay Sound, British Columbia.		84	59	71.5	71	59	65	60	57	58.5	30.04	29.94	29.99	... do	10	Variable	0—1	0
	28	do		60	55	57.5	60	55	57.5	59	57	58	30.18	30.04	30.11	Foggy to clear	0—9	Variable	0—1	0
	29	48 27 00	125 09 00	58	53	55.5	57	52	54.5	58	52	55	30.16	30.08	30.12	Foggy	0—4	NE., SE., S., SSW	0—3	Light.
	30	48 13 00	122 52 00	58	54	56	57	54	55.5	54	51	52.5	30.20	30.14	30.17	... do	0	NNE., SSE	0—2	0
Oct.	1	47 44 00	122 26 00	62	57	59.5	61	56	58.5	60	53	56.5	30.20	30.14	30.17	... do	0	SE., WSW	0—1	0
	2	Seattle, Wash		63	59	61	62	58	60	60	57	58.5	30.14	30.08	30.11	Overcast	0	SW., WSW	0—2	0
	3	do		63	57	60	62	56	59	61	56	58.5	30.08	30.00	30.04	Foggy; fair, clear	0-7-10	SW	0—1	0
	4	47 43 00	122 27 00	62	53	58	61	52	56.5	58	52	55	30.08	29.94	30.01	Fair	8—9	NW. to NE	0—2	0
	5	Port Townsend, Wash.		65	52	58.5	61	51	56	55	50	52.5	29.98	29.80	29.89	Fair to clear	7—10	NE. WNW	0—2	0
	6	Victoria Harbor, British Columbia		[illegible]	[illegible]	55.5	59	52	55.5	53	50	51.5	30.02	29.88	29.95	Clear to overcast	10—0	SSE., NNE., NW., NE	0—2	Light.
	7	48 59 00	123 24 00	58	52	55	57	51	54	57	50	53.5	30.04	29.94	29.99	Overcast	0—5	NW. and NNE. to SSE	0—2	Mod.
	8	Departure Bay, British Columbia.		60	51	55.5	59	50	54.5	57	52	54.5	30.22	29.94	30.08	Overcast to fair	0—8	Variable	0—3	Light.
	9	... do		63	51	57	61	49	55	56	51	53.5	30.26	30.20	30.23	Fair to overcast	8—0	Variable	0—3	Light.
	10	48 39 00	123 15 00	55	51	53	64	50	57	55	49	52	30.28	30.22	30.25	Overcast to fair	0—8	Variable	0—3	Light.
	11	47 03 00	124 20 00	61	54	57.5	61	53	57	60	55	57.5	30.22	29.80	30.01	Fair to overcast	8—0	E. by N. to S	1—7	Light.
	12	46 07 00	125 14 00	61	58	59.5	60	56	58	63	59	61	30.34	29.84	30.09	Squally, fair	2—6	SE. to WNW	3—8	Light.
	13	46 08 00	124 45 00	64	57	60.5	60	54	57	62	56	59	30.46	30.38	30.42	Overcast to fair	0—8	WNW. to SE	0—4	Light.
	14	Astoria, Oregon		63	56	59.5	60	55	57.5	61	56	58.5	30.40	30.22	30.31	... do	0—8	Variable	0—3	Light.
	15	do		63	54	58.5	60	53	56.5	62	57	59.5	30.20	29.96	30.08	... do	0—7	Variable	0—2	Light.
	16	do		71	55	63	64	53	58.5	60	57	58.5	30.02	29.94	29.98	Overcast	0—2	Variable	0—3	Light.
	17	do		71	50	60.5	63	49	56	61	57	59	30.38	30.04	30.21	Overcast to clear	0—9	NW. to W., E	1—4	0
	18	46 14 00	124 03 00	62	49	55.5	61	49	55	61	55	58	30.38	30.04	30.21	Fair	2—7	N. to SSE	0—4	0
	19	43 59 00	125 03 00	68	56	62	64	54	59	60	57	58.5	30.36	30.08	30.22	Overcast to clear	0—10	Variable	0—3	Light.
	20	40 42 00	124 52 00	63	55	59	61	54	57.5	59	50	54.5	30.36	30.16	30.26	Fair to clear	7—10	N. to NW	3—6	0
	21	37 49 00	122 28 30	75	54	64.5	70	53	61.5	63	52	57.5	30.16	30.02	30.09	Clear	9—10	W. to NNE	1—4	0

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, from January 1 to June 30, 1889.

Date.	Position at meridian.		Temperatures.									Barometer.			Clouds.	Weather.	Wind.		Rain.
	Lat. N.	Long. W.	Air, dry bulb. Maximum.	Air, dry bulb. Minimum.	Air, dry bulb. Mean.	Air, wet bulb. Maximum.	Air, wet bulb. Minimum.	Air, wet bulb. Mean.	Water at surface. Maximum.	Water at surface. Minimum.	Water at surface. Mean.	Maximum.	Minimum.	Mean.			Direction.	Force.	
1889.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°	°								
Jan. 1	San Francisco, Cal.		64	51	57.5	57	48	52.5	55	51	53	30.40	30.32	30.36	Cir., cum., nimb., cum.-str.	Fair to clear	NE., ESE., ENE ..	0—3	0
2	....do		56	48	52	55	47	51	55	51	53	30.30	30.22	30.26	Cir., cum., nimb.....	....do	E. by N., NE., WNW., E.	1—2	0
3	....do		57	47	52	56	47	51.5	57	51	54	30.24	29.98	30.11	Cum.-str., cum., nimb., nimb.	Overcast, and rain to fair.	NNE., NW., NE., SE.	1—7	Mod.
4	34 14 00	122 01 30	58	54	56	56	53	54.5	58	56	57	30.00	29.90	29.95	Nimb., cum., nimb ..	Squally and rainy to fair.	Variable..........	8—4	Mod.
5	34 12 00	120 32 00	64	56	60	61	54	57.5	60	57	58.5	30.04	29.96	30.00	Cum., nimb., cir.....	Fair to clear.......	NE., NNW., NW .	4—1	0
6	34 00 00	120 29 30	66	57	61.5	63	55	59	61	58	59.5	30.10	29.98	30.04	Str...................	Clear	NW., NW. by N., SW.	4—2	0
7	34 01 30	120 01 00	61	57	59	60	55	57.5	60	56	58	30.00	29.90	29.95	None................	....do	Variable..........	1—4	0
8	34 23 00	120 11 00	70	57	63.5	69	56	62.5	61	58	59.5	30.10	29.96	30.03	Nimb., cum., str., cir.-cum.	Foggy to clear......	NE., E, ESE., W.	0—3	0
9	Santa Barbara, Cal .		61	56	58.5	59	54	56.5	61	58	59.5	30.10	30.00	30.05	Cum., nimb., cir., nimb.	Overcast to fair....	Variable..........	0—2	0
10	San Diego, Cal.....		64	53	58.5	60	52	56	61	56	58.5	30.12	30.02	30.07	Nimb., cir.-cum., cum.-str., cum., nimb.	Overcast to clear..	....do	0—2	0
11	....do		60	51	55.5	58	50	54	58	56	57	30.12	30.00	30 06	Cum., cum., nimb., cir.-cum.	Clear to overcast..	....do	0—2	0
12	....do		63	55	59	62	54	58	59	56	57.5	30.04	29.92	29.98	Nimb., cum., cir.-cum.	Overcast to fair ...	....do	0—2	Light.
13	....do		59	54	56.5	57	51	54	59	56	57.5	29.92	29.64	29.78	Nimb	Overcast	....do	1—4	Mod.
14	....do		55	47	51	53	47	50	57	54	55.5	29.70	29.60	29.65	Cum., nimb., cum., cum., nimb.	Overcast to fair...	....do	1—6	Mod.
15	....do		60	46	53	56	45	50.5	59	54	56.5	29.96	29.72	29.84	Cum., cum., nimb., cir.-cum.	Fair to clear	....do	0—3	0
16	32 25 00	119 03 30	60	55	57.5	57	53	55	60	58	59	30.10	29.94	30.02	Nimb., cum., cum., nimb , cir.-cum.	Fair................	....do	2—3	0
17	32 28 45	119 13 00	65	56	60.5	60	53	56.5	60	57	58.5	30.28	30.12	30.19	Cum., cir.-cum., cum., nimb.	....do	WNW., W........	2—3	0
18	San Nicholas Island		67	55	61	64	53	58.5	61	56	58.5	30.28	30.20	30.24	Cir.-cum., cum., nimb.	Fair to clear.......	Variable..........	1—5	Light.

	19	San Diego, Cal		65	46	55.5	60	45	52.5	62	55	58.5	30.40	30.22	30.31	Cir	Clear	do	1—3	0
	20	do		81	42	61.5	74	40	57	58	55	56.5	30.40	30.22	30.31	Cir.-cum	do	do	0—3	0
	21	do		70	43	56.5	65	41	53	58	52	55	30.22	30.10	30.16	Cum	do	do	0—3	0
	22	do		65	46	55.5	64	45	54.5	60	54	57	30.26	30.10	30.18	Cum., cir	do	do	0—2	0
	23	32 43 30	117 52 00	61	46	53.5	58	45	51.5	59	54	56.5	30.30	30.24	30.27	Str	do	do	0—2	0
	24	32 43 45	119 16 00	71	57	64	65	56	60.5	62	58	60	30.30	30.14	30.22	Cir. cum. str	do	do	0—3	0
	25	San Clemente Island		59	55	57	59	55	57	59	58	58.5	30.16	30.04	30.10	Cir.-str., cir.-cum	do	do	1—2	0
	26	32 28 30	117 16 30	60	56	58	60	51	55.5	60	55	57.5	30.24	30.10	30.17	Cum.-str	do	do	0—2	0
	27	San Diego, Cal		60	46	53	58	45	51.5	58	54	56	30.32	30.18	30.25	do	do	NE., WNW., W.	0—3	0
	28	do		65	46	55.5	63	44	53.5	57	54	55.5	30.28	30.10	30.19	None	do	NE, NW., W	0—3	0
	29	do		61	46	53.5	60	44	52	58	55	56.5	30.22	30.10	30.16	do	do	Variable	0—1	0
	30	National City, Cal		63	44	53.5	62	44	53	58	53	55.5	30.28	30.18	30.23	Cir.-cum, cum	do	do	0—2	0
	31	do		71	48	59.5	66	47	56.5	59	49	54	30.30	30.20	30.25	Cum	do	do	0—2	0
Feb.	1	San Diego, Cal		72	48	60	71	46	58.5	61	56	58.5	30.34	30.22	30.28	None	do	SE., E., ESE., NW.	0—2	0
	2	do		81	49	65	74	47	60.5	59	54	56.5	30.30	30.12	30.21	do	do	ENE	0—6	0
	3	do		67	49	58	66	47	54.5	64	48	56	30.22	30.10	30.16	do	do	S., N., W., ENE.	0—2	0
	4	32 48 00	117 26 00	65	50	57.5	63	48	53.5	62	56	59	30.20	30.10	30.15	Cum	do	Variable	0—2	0
	5	33 36 00	118 13 00	61	51	56	59	51	55	60	56	58	30.24	30.12	30.18	Cum., nimb., cir-cum., cir.	Foggy to fair	do	0—2	0
	6	34 03 30	119 29 00	60	54	57	57	53	55	60	57	58.5	30.20	30.10	30.15	Cum., cir., cum.-str. cir., cum., nimb.	Fair to clear	do	0—2	0
	7	Santa Cruz Island		62	55	58.5	60	54	57	60	57	58.5	30.18	30.06	30.12	Nimb., cum., cum.-str.	Overcast to clear	do	0—4	0
	8	33 48 00	120 03 00	60	55	57.5	57	54	55.5	59	56	57.5	30.20	30.10	30.15	Cir.-cum., cir., cum., nimb.	do	do	0—3	0
	9	34 06 00	120 22 30	66	52	59	64	50	57	59	56	57.5	30.28	30.18	30.23	Cir., cir.-cum	Clear	W., NE., E., NNW.	0—2	0
	10	Santa Barbara, Cal		65	50	57.5	62	49	55.5	61	57	59	30.30	30.16	30.23	Cir.-cum	do	Variable	0—2	0
	11	34 20 30	119 38 00	65	53	59	60	50	55	61	57	59	30.20	30.10	30.15	None	do	do	0—1	0
	12	33 58 00	119 21 30	84	55	69.5	75	53	64	62	57	59.5	30.20	30.10	30.15	Str., cir.-str., cir	do	E., ENE., S., W	0—6	0
	13	33 25 00	119 07 00	63	55	59	62	51	56.5	59	57	58	30.10	29.80	29.95	Cum., cum., nimb, cir-cum.	Clear to overcast	W., WSW., W. by N. W. by S.	0—7	0
	14	33 09 00	118 11 00	62	54	58	60	50	55	60	56	58	29.82	29.74	29.78	Cum., nimb., cir.-cum., cum., nimb.	Overcast to fair	Variable	3—7	0
	15	San Diego, Cal		54	50	52	53	48	50.5	58	57	57.5	29.98	29.82	29.90	Cum., nimb., nimb.	Fair to overcast	WSW., NNW., W., WSW.	1—6	Light.
	16	do		56	50	53	51	48	49.5	58	57	57.5	30.20	29.98	30.09	Cum., nimb	Fair	WSW., NE., W., W. by S.	2—7	0
	17	San Diego, Cal		57	48	52.5	52	42	47	57	54	55.5	30.38	30.22	30.30	Cum., cir., cir.-cum., str.	Fair to clear	Variable	0—2	0
	18	do		65	42	53.5	58	40	49	58	54	56	30.34	30.20	30.27	Cir.-str., cum.-str., cir.	Clear	do	0—2	0
	19	do		73	45	59	67	42	54.5	60	54	57	30.34	30.24	30.29	None	do	do	0—3	0
	20	do		81	46	63.5	68	45	56.5	62	54	58	30.34	30.26	30.30	Cum.-str	do	N., NE., WNW., NW.	0—2	0
	21	do		73	48	60.5	70	45	57.5	60	55	57.5	30.34	30.20	30.27	Cir.-str. cum	do	WNW., NE.	0—2	0
	22	do		70	53	61.5	65	52	58.5	60	54	57	30.24	30.12	30.18	Cum., nimb., str	Fair to clear	ESE., SSW	0—1	0
	23	National City, Cal		74	50	62	67	49	58	64	55	59.5	30.14	29.98	30.06	Cum.-str., cir., cir.-cum.	do	SE., NW	0—1	0
	24	do		58	51	54.5	56	51	53.5	58	54	56	30.06	30.00	30.03	Cum., nimb., nimb.	Overcast to fair	N. E. S. SSW	0—5	Mod.
	25	do		63	55	59	59	54	56.5	58	55	56.5	30.22	30.02	30.12	Cum., cum.-str., nimb., cum., nimb.	Overcast to clear	Variable	0—2	Mod.
	26	San Diego, Cal		68	51	59.5	67	50	58.5	61	57	59	30.30	30.24	30.26	Cir., cum.-str	Clear	E. W, NW	0—3	0

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, from January 1 to June 30, 1889—Continued.

Date.	Position at meridian.		Temperatures.									Barometer.			Clouds.	Weather.	Wind.		Rain.
	Lat. N.	Long. W.	Air, dry bulb.			Air, wet bulb.			Water at surface.								Direction.	Force.	
			Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.					
1889.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°	°								
Feb. 27	29 54 30	117 58 30	64	60	62	63	58	60.5	62	60	60	30.22	30.10	30.16	None	...do	NNW., NW	3—4	0
28	28 52 00	118 16 30	71	61	66	65	58	61.5	64	60	62	30.10	29.98	30.04	Cir., cum., str., cum., nimb.	...do	Variable	0—4	0
Mar. 1	26 58 00	117 02 00	80	60	70	69	59	64	70	63	66.5	30.14	30.06	30.10	Cir.-cum., cir.-str., cum., nimb., cum.	Fair to clear	N. to W. by N	1—2	0
2	24 51 00	115 43 00	68	64	66	66	62	64	68	64	66	30.14	30.04	30.09	Cir., cum.-str., cir.-cum.	Clear	NE. to W	1—3	0
3	21 52 00	115 11 00	73	65	69	68	63	65.5	71	36	68.5	30.10	30.00	30.05	Cum.-str., cir.-cum., cir.	Clear to fair	N., NW	0—2	0
4	18 42 00	114 45 00	72	67	69.5	68	64	66	71	69	70	30.02	29.98	30.00	Cir.-cum., cum., nimb., nimb.	Overcast to fair	NW., NNW., E	0—2	Light.
5	Clarion Island		74	69	71.5	71	68	69.5	72	69	70.5	30.02	29.92	29.97	Cir.-cum., cum, nimb., cum., nimb.	...do	E. ENE., NNE	1—4	Light.
6	..do		76	70	73	73	65	69	74	69	71.5	30.02	29.94	29.98	Cum., cir.-cum., cum., nimb.	Fair to clear	N. to ENE	0—4	0
7	18 27 00	112 24 00	75	69	72	68	64	66	74	70	72	30.00	29.88	29.94	Cum., cir.-cum., cum.-str.	Clear	N. to NE	2—3	0
8	Socorro Island		73	68	70.5	68	64	66	73	70	71.5	29.98	29.88	29.93	Cir.-cum., cum., nimb.	Clear to fair	NW. to E	0—2	0
9	...do		84	65	74.5	74	62	68	73	70	71.5	30.00	29.94	29.97	Cum.-nimb., cir.-cum., nimb.	Fair to overcast	Variable	0—6	Light.
10	San Benedicto Island.		75	70	72.5	69	65	67	73	70	71.5	30.02	29.92	29.97	Nimb., cum., cir.-cum., cum., nimb.	Overcast to fair	NNE. to NW	0—3	0
1	21 44 18	110 03 30	73	69	71.0	68	64	66	74	69	71.5	30.00	29.88	29.94	Cir.-cum., cum., cir.-str.	Clear	NW. to NNE	2—4	0
12	Pichilinque Bay, Lower California		73	66	69.5	71	64	67.5	72	66	69	29.98	29.86	29.92	Str., cir., cum.-str.	...do	W. to NNE	0—3	0
13	...do		79	64	71.5	71	61	66	74	69	71.5	29.96	29.78	29.87	Cir	...do	Variable	0—3	0
14	...do		74	62	68	68	59	63.5	73	65	69	29.96	29.82	29.89	None	...do	...do	1—4	0
15	...do		75	63	69	70	62	66	73	67	70	29.98	29.84	29.91	Cir.-cum	...do	...do	0—4	0
16	24 31 00	110 29 15	76	65	70.5	71	60	65.5	73	66	69.5	30.02	29.90	29.96	...do	...do	S. to WNW	1—3	0
17	25 23 48	110 50 00	72	64	68	65	58	61.5	71	66	68.5	30.12	30.02	30.07	Cir.-cum, cir	...do	N. to WNW	1—4	0
18	25 59 00	111 07 15	73	65	69	64	60	62	70	66	68	30.12	29.96	30.04	None	...do	NNW., NW	3—5	0

	19	26 45 30	111 53 00	70	66	68	60	65	67.5	70	66	68	30.04	29.94	29.99	....do	....do	NW. by W., to NNE.	1—5	0
	20	27 23 30	111 25 00	75	65	70	69	62	65.5	70	66	68	30.04	29.94	29.99	....do	....do	Variable	0—3	0
	21	Guaymas, Mexico		73	66	69.5	64	59	61.5	68	65	66.5	30.00	29.94	29.97	...do	...do	WSW. to NW	0—5	0
	22	do		77	67	72	76	62	69	74	65	69.5	30.00	29.94	29.97	Cir	....do	Variable	0—5	0
	23	28 01 00	111 24 30	71	68	69.5	65	60	62.5	69	61	65	30.10	30.00	30.05	Cir., cum	.. do	W. to NNW	1—4	0
	24	29 56 30	113 01 15	73	64	68.5	69	62	65.5	61	66	63.5	30.10	29.90	30.00	Cir	...do	Variable	1—3	0
	25	31 16 00	113 29 00	70	61	65.5	67	59	63.5	67	64	65.5	30.00	29.92	29.96	Cum.-str., cir.-str	....do	E., SE., SSW	0—2	0
	26	31 31 30	114 17 30	70	59	54.5	69	58	63.5	68	64	66	30.08	30.00	30.04	Cir.-str., cir.-str., nimb.	...do	Variable	0—2	0
	27	30 40 30	114 28 30	82	62	72	72	60	66	72	65	68.5	30.10	30.04	30.07	Cir	....do	NE. to S	0—1	0
	28	29 48 00	114 23 00	76	66	71	72	64	68	74	64	69	30.10	30.00	30.05	Cir., cir.-str	....do	NNE. to SE	0—1	0
	29	29 40 00	114 02 00	77	66	71.5	71	61	66	72	65	68.5	30.04	29.90	29.97	Cir., cum., cum., nimb., cum.-str., cir-cum.	Clear to fair	E., W., N., NW. by N.	0—1	0
	30	28 02 00	111 19 00	80	64	72	70	61	65.5	75	63	69	29.94	29.84	29.89	Cum., cir.-cum., cir	Fair	SE. to SSW	0—2	0
	31	27 44 00	110 40 30	73	67	70	71	64	67.5	73	68	70.5	29.98	29.90	29.94	Cir., cir-cum., cum.-str.	Clear	Variable	0—2	0
Apr.	1	27 39 00	110 41 30	74	64	69	72	64	68	74	67	70.5	30.00	29.88	29.94	Cir., cum., cir.-cum., nimb., cum.-str.	Clear to fair	....do	0—2	0
	2	26 01 00	109 28 00	82	70	76	74	68	71	76	69	72.5	29.98	29.88	29.93	Cum., cir.-cum., cum-nimb.	....do	....do	0—2	0
	3	La Paz, Lower California.		79	68	73.5	76	66	71	75	70	72.5	30.04	29.90	29.97	Cir., cir.-str., cir., cum.	Clear	....do	0—2	0
	4	Pichilinque Bay, Lower California.		80	66	73	73	62	67.5	75	69	72	30.02	29.88	29.95	Cir., cir.-cum., cir.-str.	....do	....do	0—2	0
	5	....do		83	69	76	74	63	68.5	75	68	71.5	29.94	29.76	29.85	Cir., cir.-cum	....do	....do	0—4	0
	6	La Paz, Lower California.		79	68	73.5	74	65	69.5	78	70	74	29.92	29.80	29.86	None	....do	....do	0—3	0
	7	San Lucas Bay, Lower California.		80	70	75	74	67	70.5	75	71	73	29.94	29.84	29.89	Nimb., cum., nimb., cir.-cum.	....do	....do	0—3	0
	8	24 33 30	112 03 00	69	64	66.5	66	61	63.5	70	66	68	30.00	29.90	29.95	Cum., nimb., cir.-cum., cir.	Clear	W. to NW. by W.	1—3	0
	9	Magdalena Bay, Lower California.		68	63	65.5	65	60	62.5	68	64	66	30.00	29.92	29.96	Cum., nimb	Fair to clear	W. to NW	1—4	0
	10	26 07 00	113 33 30	65	62	63.5	63	59	61	65	62	63.5	30.04	29.96	30.00	Cir., cum., cum., nimb., cum.	....do	... do	3—4	0
	11	San Bartolme Bay, Lower California.		64	60	62	61	58	59.5	63	59	61	30.06	30.00	30.03	Cir., cir.-cum., nimb., cum., nimb., cir.	Fair to overcast	WSW to NW	2—4	0
	12	27 52 00	115 07 00	66	61	63.5	63	59	61	65	59	62	30.10	30.00	30.05	Cum., cir., cum	Fair to clear	W. to ENE	1—6	0
	13	San Quentin Bay, Lower California.		61	59	60	60	57	58.5	60	57	58.5	30.14	30.02	30.08	Cum., nimb., cum., cir.	Cloudy to clear	W. to NNW	2—4	0
	14	32 20 00	117 06 30	62	57	59.5	59	55	57	61	59	60	30.12	30.00	30.06	Nimb., cum., nimb., cum., cir.-str., cir.	....do	Variable	1—3	0
	15	San Diego, Cal		63	54	58.5	60	52	56	66	59	62.5	30.20	30.12	30.16	Cir.-cum	Clear	WNW. NW by W.	0—4	0
	16	....do		70	54	62	67	52	59.5	66	60	63	30.22	30.10	30.16	Cum., cir., cir.-cum	....do	W., WNW	0—2	0
	17	....do		72	55	63.5	67	53	60	67	59	63	30.08	29.84	29.96	Cir	. do	E. NW., WNW	0—2	0
	18	....do		71	59	65	65	57	61	66	61	63.5	29.90	29.82	29.86	Cir., cir.-cum	Clear to fair	Variable	0—2	0
	19	....do		68	58	63	65	57	61	67	60	63.5	30.08	29.90	29.99	Nimb., cum., cir., cir.-cum.	Fair to clear	SE. to SW	0—2	0

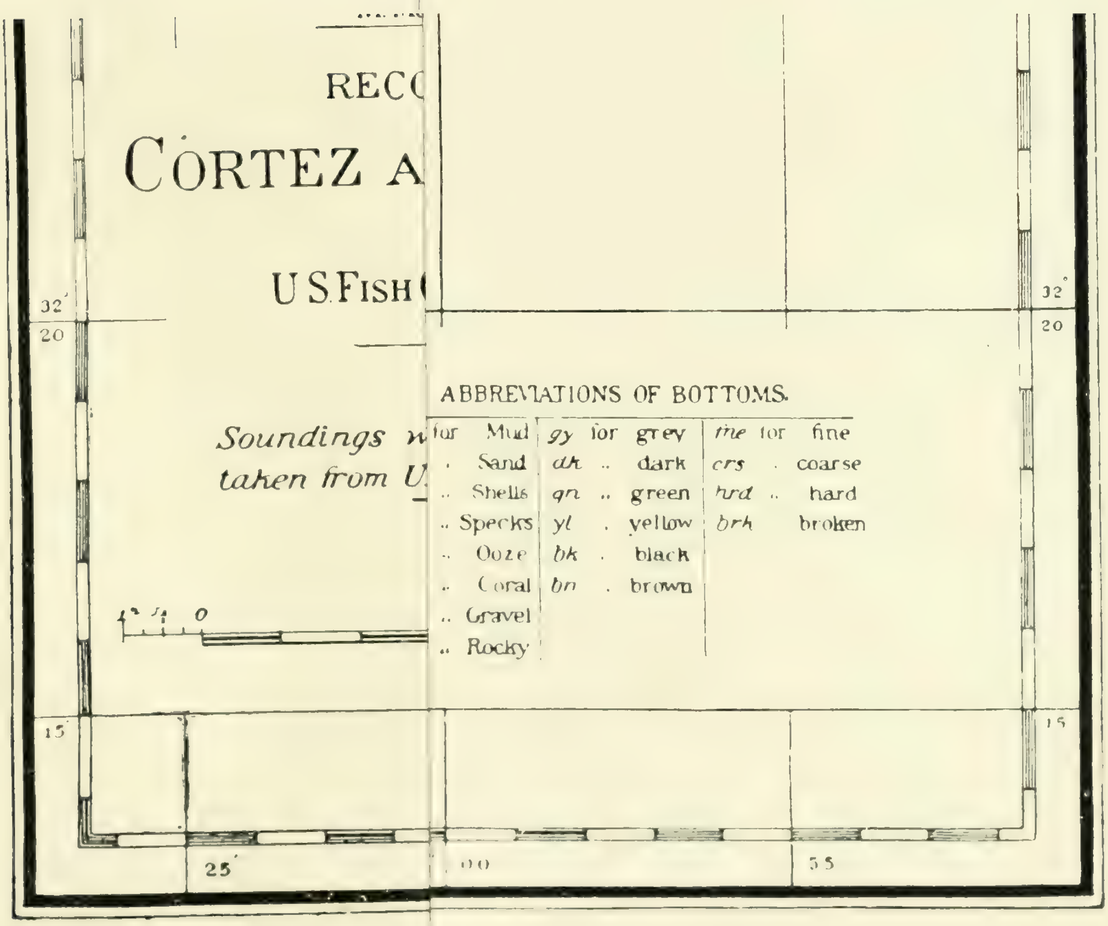
Record of meterological observations by the U. S. Fish Commission steamer Albatross, from January 1 to June 30, 1889—Continued.

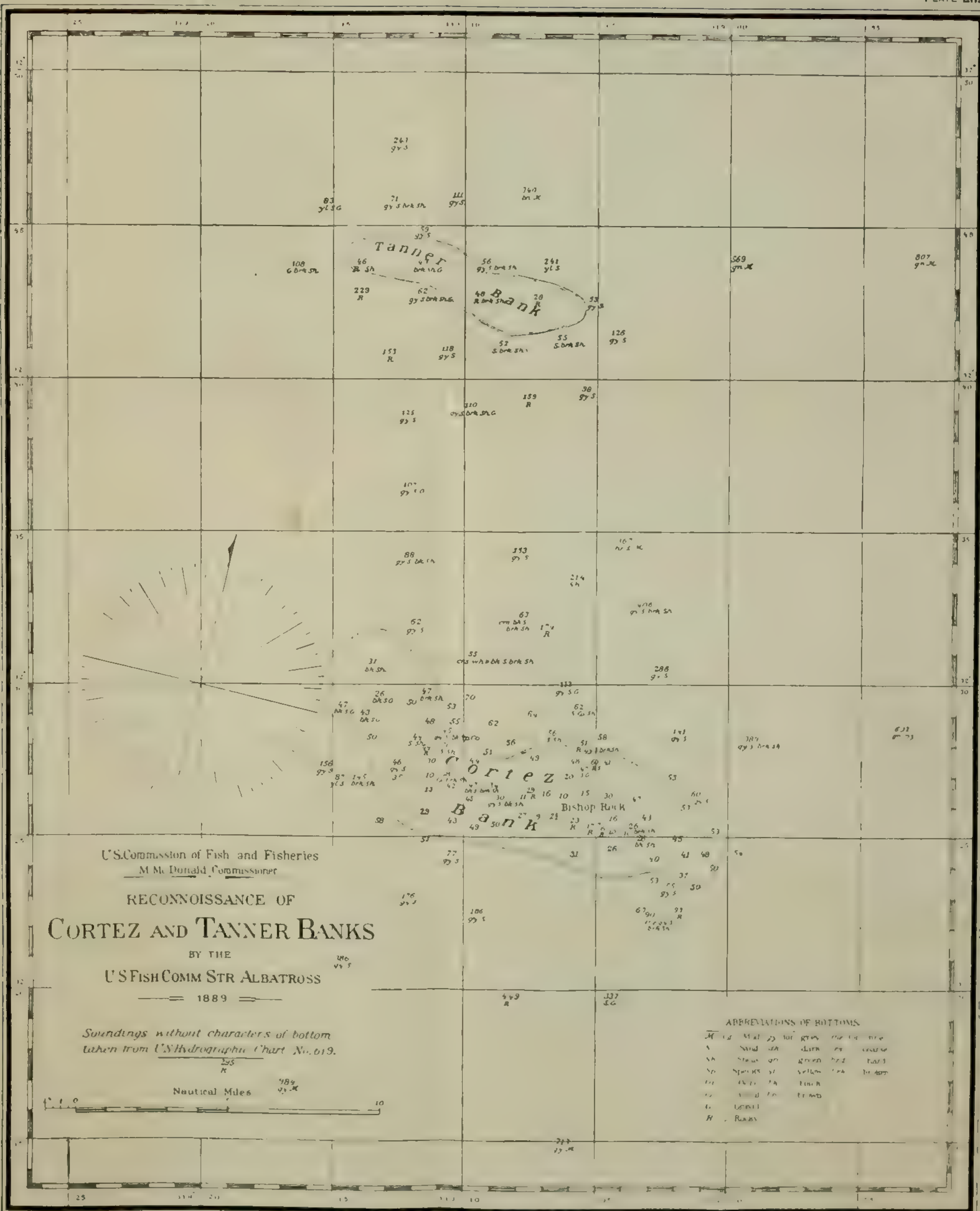
Date.	Position at meridian.		Temperatures.									Barometer.			Clouds.	Weather.	Wind.		Rain.
	Lat. N.	Long. W.	Air, dry bulb.			Air, wet bulb.			Water at surface								Direction.	Force.	
			Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.					
1889.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°	°								
Apr. 20	San Diego, Cal		68	60	64	63	58	60.5	66	61	63.5	30.24	30.06	30.15	Cum., nimb., cum. cir., cir.-cum.	Fair to clear	N. to W	0—2	0
21	....do		66	59	62.5	63	58	60.5	68	60	64	30.24	30.14	30.19	Cum., nimb., cir., cir.-str.	Overcast to clear..	NE. to W	0—3	0
22	.. do		70	59	64.5	67	57	62	69	63	66	30.16	29.92	30.04	Nimb., cir	Clear	SE., W., WSW	0—3	0
23	34 14 00	119 41 00	67	57	62	64	56	60	64	55	59.5	30.04	29.92	29.98	Cir., str., cir.-str., cum., nimb.	Clear to overcast..	Variable	0—4	0
24	36 20 00	121 57 00	58	55	56.5	56	54	55	57	51	54	30.22	30.02	30.12	Cum., nimb., cir.-str., cir., cum., nimb., cir.	Overcast to fair ...	WNW. to NW. by N.	3—5	0
25	San Francisco, Cal .		63	52	57.5	60	52	56	61	55	58	30.28	30.14	30.21	Nimb., cum., nimb., cir., cum.	Overcast and foggy to fair.	Variable	0—5	0
26	....do		58	53	55	56	52	54	60	55	57	30.22	30.08	30.15	Cum., nimb., cir ...	Cloudy and misty to clear and pleasant.	SW., veering to WSW.	1—5	Light.
27	....do		60	53	56	58	52	55	61	57	59	30.20	30.14	30.17	Nimb., cum., cir....	Cloudy and misty, passing showers.	SW. by W., veering to WSW.	2—7	Light.
28	... do		63	54	58	59	52	55	63	57	60	30.18	30.04	30.11	Cum., cir	Clear and pleasant	Variable	0—4	0
29	....do.		59	53	56	56	52	54	61	56	58	30.14	30.06	30.10	Cum., cir., cir.-cum	Clear to fair	S. to WSW	1—5	0
30	....do		57	52	54	55	51	53	60	56	58	30.18	30.08	30.13	Nimb., cum., cir.....	Overcast and misty to fair.	WSW., SW., SSW.	1—5	0
May 1	....do		56	51	53	55	50	52	59	54	56	30.10	30.02	30.06	Cum., nimb.........	Overcast and drizzly to fair.	SE. to W. by N ...	0—5	Light.
2	....do		60	54	57	56	53	54	60	57	58	30.10	30.00	30.05	Cum., nimb., cir.....	Overcast to clear and pleasant.	S. to WSW	1—4	0
3	San Francisco, Cal		58	53	55	55	51	53	60	57	58	30.14	30.08	30.11	Cir., cum., nimb.....	Clear and plesaant to cloudy.	WNW. to SSW...	0—4	0
4	...do		59	55	57	59	52	55	60	56	58	30.10	29.86	29.98	Cum., nimb	Fair to overcast, with rain.	W. veering to SSE.	1—4	Light.
5	....do		57	54	55	56	53	54	59	55	57	30.04	29.74	29.89	...do	Overcast and rainy to fair.	SSE. veering to WSW.	2—7	Light.
6	....do		57	53	55	56	51	53	58	56	57	30.04	29.94	29.99	Nimb , cum	Cloudy to fair....	SW., S., SSE	1—5	0
7	.. do		59	52	55	56	50	53	59	56	57	30.04	30.00	30.02	Cum., cir., nimb	Clear and pleasant to cloudy.	Veering from SSE. to W.	1—4	0

	8	...do		64	52	58	60	51	55	60	55	57	30. 20	30. 00	30. 10	Cum., cir	Clear and pleasant.	W., WSW., N.	1—4	0
	9	...do		67	55	61	64	54	59	65	57	61	30. 22	30. 10	30. 16	Cir	...do	SW., NW.	0—2	0
	10	...do		70	54	62	67	53	60	63	57	60	30. 12	30. 00	30. 06	Cum., nimb	...do	S. to WSW.	0—1	0
	11	...do		65	56	60	63	55	59	62	57	59	30. 10	30. 02	30. 06	Nimb., cum	Overcast and cloudy.	W. and SW	0—1	0
	12	...do		67	57	62	63	54	58	63	56	59	30. 10	30. 02	30. 06	Cum., nimb., cir	Overcast to clear	S. and SW	0—1	0
	13	...do		65	58	62	62	54	58	61	57	59	30. 12	30. 04	30. 08	...do	Rainy to fair	SE., SW., W	0—1	Light.
	14	...do		62	53	57	58	50	54	60	57	58	30. 10	30. 00	30. 05	Cir., cum., nimb	...do	SW., SSW	0—2	Light.
	15	...do		59	52	55	55	50	52	59	57	58	30. 24	30. 08	30. 16	Nimb., cum	Fair	W. and WSW	0—5	0
	16	...do		64	52	58	58	49	53	62	55	58	30. 30	30. 22	30. 26	Cum., cir	...do	N. and W	0—2	0
	17	...do		69	54	61	64	51	57	62	54	58	30. 32	30. 28	30. 30	Cir.-cum., nimb	...do	W. and WSW	0—2	0
	18	...do		74	55	64	70	54	62	62	56	59	30. 32	30. 12	30. 22	Cum., cir	...do	SW. by WSW	0—1	0
	19	...do		79	59	69	73	57	65	66	59	62	30. 10	29. 92	30. 01	do	...do	WNW., SW., SSW	0—2	0
	20	...do		61	54	57	58	53	55	61	56	58	30. 16	30. 02	30. 09	Cir.-cum., nimb	...do	SW. and WSW	0—3	0
	21	...do		61	53	57	58	50	54	60	51	55	30. 14	30. 06	30. 10	Cir.-cum	Fair to squally	SSW. to W. by N.	0—7	0
	22	29 18 00	123 50 15	56	53	54	54	51	52	55	50	52	30. 14	30. 00	30. 07	Cir.-cum., str	Fair	N. by W. to NW. by W.	3—5	0
	23	42 17 00	124 32 00	56	53	54	54	52	53	56	54	55	30. 30	30. 16	30. 23	Nimb., cum., cir., str	Overcast to fair	NNW. to WNW.	3—6	0
	24	46 16 00	124 09 00	67	55	61	63	53	58	60	56	58	30. 40	30. 32	30. 36	Cir., str., cum., nimb.	Fair to overcast and drizzly.	Variable	0—3	Light.
	25	48 57 00	123 22 30	63	54	58	62	53	57	62	53	57	30. 40	30. 20	30. 30	Nimb., cum., cir	Overcast to fair	...do	0—1	0
	26	Departure Bay, Vancouver I., B. C.		75	54	64	73	53	63	70	55	62	30. 20	29. 84	30. 02	Cum., nimb	Fair	...do	0—1	0
	27	Victoria, B. C		65	55	60	60	54	57	55	52	53	30. 14	29. 90	30. 07	...do	Fair to overcast, with rain.	SSW. and S	1—4	Light.
	28	...do		65	55	60	62	53	57	61	52	56	30. 18	30. 08	30. 13	Nimb., cum., cir	Overcast and rainy to fair.	S., SSE., SE., NE.	0—1	Light.
	29	Port Townsend, Wash.		63	53	58	63	50	56	58	52	55	30. 04	29. 90	29. 97	Cir., cum., nimb	Overcast, rainy, and squally.	Variable	0—6	Light.
	30	Seattle, Wash		63	53	58	60	50	55	60	51	55	30. 30	30. 06	30. 18	Nimb., cir., cum	Fair and rainy	...do	1—4	Light.
	31	...do		66	57	61	61	54	57	60	55	57	30. 30	30. 20	30. 25	...do	Overcast to fair	W., WSW., WNW.	0—2	0
June	1	...do		72	56	64	66	54	60	63	55	59	30. 26	30. 08	30. 17	Cir., cum	Fair	W. and NW	0—2	0
	2	...do		82	58	70	72	55	63	67	56	61	30. 14	29. 90	30. 02	...do	...do	Variable	0—2	0
	3	...do		74	59	66	68	57	62	69	55	62	30. 06	29. 90	29. 98	Cir., cum., str., nimb	...do	WSW., NW., NNE	0—2	0
	4	...do		63	54	58	59	53	56	65	52	58	30. 22	30. 08	30. 15	Nimb., cum., cir	Overcast and drizzly.	ENE., veering to W.	0—1	Light.
	5	...do		64	52	58	58	51	54	64	52	58	30. 26	30. 12	30. 19	Cum., nimb., cir	Fair	SW. to WNW	0—2	0
	6	48 09 00	122 46 00	61	53	57	56	51	53	56	53	54	30. 20	30. 10	30. 15	Cir.-cum.-str	...do	S. to WSW	0—2	0
	7	46 45 00	124 36 00	65	54	59	61	52	56	61	52	56	30. 18	30. 12	30. 15	Cir.-cum.	...do	SSE, to N. by W.	0—3	0
	8	44 00 00	124 57 00	61	54	57	58	53	55	57	51	54	30. 24	30. 16	30. 20	Cum., cir	...do	N. by W., NW	2—4	0
	9	Off Yaquina Head, California.		58	54	56	57	52	54	57	51	54	30. 24	30. 10	30. 17	Cir.-cum	Fair and misty	NW	3—6	0
	10	46 07 00	124 04 00	65	55	60	62	54	58	67	54	60	30. 16	30. 10	30. 13	...do	Fair	NW. by N. to WSW.	1—6	0
	11	Astoria, Oregon		63	56	59	60	55	57	66	62	64	30. 18	30. 10	30. 14	...do	...do	W., WSW	0—5	0
	12	...do		62	57	59	61	54	57	65	60	62	30. 12	30. 06	30. 09	Cum., nimb., cir., str.	...do	W., WNW., SW.	0—4	0
	13	46 00 30	124 07 00	59	54	56	57	52	54	64	56	60	30. 10	30. 00	30. 05	Nimb., cum., cir., str.	Misty to fair	Variable	0—2	Light.
	14	48 30 00	124 56 00	58	53	55	56	52	54	57	52	54	30. 06	30. 00	30. 03	Nimb., cir., cum	Overcast and thick.	Variable	0—2	0
	15	46 12 30	123 11 00	68	53	60	63	49	56	63	50	56	30. 14	30. 04	30. 09	Nimb., cum., cir.-str.	Overcast and foggy	W. to S.	0—5	0
	16	Seattle, Wash		64	54	59	60	52	56	59	57	54	30. 24	30. 14	30. 19	Nimb., cir.-cum	Overcast to fair	S. to NE	0—1	0
	17	...do		59	53	56	56	51	53	57	52	58	30. 28	30. 18	30. 23	Nimb., cum., cir.-str.	Overcast	NNW., N., NNE.	0—1	0
	18	...do		66	50	58	62	49	55	61	52	56	30. 28	30. 12	30. 20	Cir., nimb., cum., str.	Overcast to fair	SW. to NNW	0—1	0

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, from January 1 to June 30, 1889—Continued.

Date.	Position at meridian. Lat. N.	Position at meridian. Long. W.	Air, dry bulb. Maximum.	Air, dry bulb. Minimum.	Air, dry bulb. Mean.	Air, wet bulb. Maximum.	Air, wet bulb. Minimum.	Air, wet bulb. Mean.	Water at surface. Maximum.	Water at surface. Minimum.	Water at surface. Mean.	Barometer. Maximum.	Barometer. Minimum.	Barometer. Mean.	Clouds.	Weather.	Wind. Direction.	Wind. Force.	Rain.
1889.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°	°								
June 19	47 34 00	122 31 00	70	54	62	66	52	59	67	54	60	30.24	30.14	30.19	Cir.-cum	Fair	ESE., veering to WNW.	0—1	0
20	Seattle, Wash		74	56	65	67	54	60	70	55	62	30.24	29.94	30.09	None	...do	SW., W., WSW	0—3	0
21	...do		71	56	63	65	54	59	65	56	60	30.12	29.90	30.01	None	...do	W., WSW., N	0—2	0
22	Seattle, Wash		63	54	58	60	52	56	62	55	58	30.34	30.00	30.17	Cum., nimb	Overcast and cloudy	ESE. to WNW. to ENE.	0—2	0.
23	...do		63	53	58	57	50	53	60	52	56	30.46	30.22	30.34	Cir., cum., nimb	Misty to fair	SE. to WNW	0—3	Light.
24	47 52 00	122 30 00	71	54	62	63	52	57	60	55	57	30.26	30.10	30.18	Cir., cum., str	Fair	W., NW. to SW	0—2	0.
25	Port Townsend, Wash.		64	57	60	60	54	57	59	53	56	30.16	30.02	30.09	Cir., cum., nimb	Overcast and misty.	Variable	0—1	Light.
26	...do		62	57	59	58	56	57	56	53	54	30.02	29.80	29.91	Nimb., cum	Overcast and drizzly.	Variable	0—1	Light.
27	48 12 00	122 30 00	60	55	57	57	53	55	55	53	54	29.82	29.76	29.79	Nimb	Overcast, rainy, and squally.	SE., S., SSW	0—5	Light.
28	47 30 00	125 40 00	56	54	55	56	53	54	57	53	55	29.92	29.80	29.86	Cumb., nimb	Overcast and rainy.	SE. to SSW	1—6	Light.
29	47 22 00	125 35 00	60	54	57	58	53	55	58	52	55	30.10	29.92	30.01	Cum., nimb	...do	S. by E. to WSW	2—4	Light.
30	48 58 00	123 00 00	63	52	58	58	51	54	59	51	55	30.24	30.10	30.17	Nim., cum., cir	Overcast to fair	Variable	0—2	0.


RECC
CORTEZ A
U.S.FISH
Soundings w
taken from U
ABBREVIATIONS OF BOTTOMS.
for Mud
.. Sand
.. Shells
.. Specks
.. Ooze
.. Coral
.. Gravel
.. Rocky
gy for grey
dk .. dark
gn .. green
yl .. yellow
bk .. black
bn .. brown
fne for fine
crs .. coarse
hrd .. hard
brk .. broken
32'
20
15
25'
00
55


Tanner Bank
Cortez Bank
Bishop Rock
U.S. Commission of Fish and Fisheries
M. McDonald, Commissioner
RECONNOISSANCE OF
CORTEZ AND TANNER BANKS
BY THE
U. S. FISH COMM. STR. ALBATROSS
1889
Soundings without characters of bottom taken from U.S. Hydrographic Chart No. 619.
Nautical Miles
ABBREVIATIONS OF BOTTOMS.

5.—REPORT OF OPERATIONS AT THE LABORATORY OF THE U. S. FISH COMMISSION, WOOD'S HOLL, MASS., DURING THE SUMMER OF 1888.

By JOHN A. RYDER, PH. D., Assistant in charge of Laboratory.

The biologists who worked in the laboratory of the U. S. Fish Commission at Wood's Holl, Mass., during the season of 1888 were as follows: The Commissioner, Prof. Marshall McDonald, Prof. W. K. Brooks, Dr. E. A. Andrews, Mr. S. Watase, Mr. T. H. Morgan, Mr. C. F. Hodge, Mr. H. H. Field, Mr. W. McM. Woodworth, Mr. C. H. Eigenmann, Mrs. Rosa Smith Eigenmann, Mr. C. F. W. McClure, Mr. J. Warne Phillips, Dr. H. N. Mateer, Professor Miller, Prof. Spencer Trotter, Mr. Geo. H. Parker, Mr. W. S. Marshall, and the writer.

The laboratory was not formally opened for investigation until about July 1st. On that date the writer arrived, as the representative of the University of Pennsylvania, and began making collections of the larval and post-larval stages of fishes which have been preserved in about 150 vials and jars for further study. The actual investigations conducted by the assistant in charge relate to the development of the sea bass and the development and anatomy of the sturgeon. Brief preliminary notices of this work have appeared in the American Naturalist for the months of July and August, 1888. The general results on the sturgeon will be published as a monograph by the writer, and will deal with the scientific and economic questions related to the inquiry.

In the matter of collections the writer would acknowledge the important assistance which he has received from Mr. V. N. Edwards, collector of the Commission at Wood's Holl, whose familiarity with the haunts and habits of the native fishes is most extensive. Many of the series collected serve to bring the earlier stages figured and described by Mr. Agassiz and the writer into connection with the final form and coloration assumed by the adult. This work is one of the most important which can be undertaken by the Commission, as it will bring to light many very remarkable facts in connection with the life history and habits of marine species and afford the means of continuing and extending the very valuable investigations undertaken by Lütken and published in that author's *Spolia Atlantica*. Many fishes undergo such startling and

profound changes of color in the course of their metamorphosis into the adult stage that it seems desirable that a pictorial record of such changes should be undertaken. The only way in which it is possible to carry out this plan is to have the young fishes figured by a competent artist from living specimens kept in the system of aquaria now in operation in the hatching rooms of the station. A beginning has been made in preparing a series of colored sketches of the young and the sexes of the sea bass by Mr. S. F. Denton, a water-color artist of very marked ability; these sketches prove that a great deal still remains to be worked out for any one species, as regards the changes from youth to adolescence and the equally great differences existing in many cases in the form and coloration of the sexes, and when published in connection with the development of a given species, they will constitute monographs of the most enduring economic and scientific value as contributions to fish-cultural literature, while their value as purely scientific productions will in no way be diminished.

Little is known of the histological details of the structure of the alimentary canals of fishes, and it affords the writer great pleasure to state that during the present season from July 17 to August 28 Mr. C. F. W. McClure, a fellow in biology in Princeton College, made a collection of the viscera of the common fishes as a basis for an extended study in this direction. These materials were prepared with great care and will no doubt afford valuable scientific results, especially as to the structure and functions of the regions of the alimentary tract in different forms. The economic bearings of such investigations in comparative histology and physiology are obvious.

Equally important collections of the brains of fishes have been made by another fellow in biology from Princeton College, Mr. J. Warne Phillips. Sixty-nine brains of fishes were exposed in the skull by him and carefully hardened in Müller's fluid for sectioning according to the formula of Weigert. These sixty-nine include twenty-two species, of which six are Selachians and one a Ganoid. This series will be of great value in working out the architecture of the brain in these types and, in conjunction with results already obtained or under way at the hands of Dr. H. F. Osborn, will be of great service in making further comparisons with higher types, and possibly some light may be thus obtained as to the psychology of fishes.

Mr. Phillips also secured a series of sponges, 4 species; cœlenterates, 5 species; echinoderms, 7 species; worms, 15 species; mollusca, 6 species; fishes, 21 species; a series of the eggs of Limulus and also of the squid; and a large number of starfishes, sea-urchins, holothurians, and skates for dissection.

Mr. C. F. Hodge, of Johns Hopkins University, Baltimore, made a series of injections of the vascular system of the common sand shark, flounder, and hake, and also prepared a skeleton of the flounder for the purpose of study in connection with a series of embryos of the common

species, collected by Mr. V. N. Edwards, and which it is hoped will furnish some of the material for a monograph upon the life history or development and curious metamorphosis of this type of fishes. This monograph it is proposed to put into the hands of a competent investigator, who has already applied for the material.

Mr. Hodge also carried on a series of experiments upon starfishes, to determine the enemies which prey upon them, the *Libinia*, or spider crab, being one of these. Experiments were also tried with the king crab, or *Limulus*, which it is strongly suspected is also an enemy of starfishes. These researches have a bearing upon the questions now presented to the Commission in relation to the best means of preventing the ravages of the starfish upon the oyster beds of Long Island Sound, that work being now in progress under the direction of J. A. Smith, mate U. S. N., of the U. S. Fish Commission steamer *Fish Hawk*, with Mr. Hodge as the scientific observer and expert, to determine the conditions of temperature and the necessary conditions of density of the sea water in which the starfish thrives.

Mr. H. H. Field, representing Harvard College, took up the special study of the genesis of the Wolffian body, or kidney, in fishes from its first appearance in the embryo. For this purpose, the eggs of the common barred killifish (*Fundulus*) were laid under contribution, these ova being obtained by artificial fertilization and developed in the hatching apparatus in the hatching room. The pelagic ova of other species were obtained by Mr. Field with the use of the tow net.

Mr. and Mrs. C. H. Eigenmann occupied a table in the laboratory during the month of August as representatives of Harvard College. They took up the study of the general development of fishes. For this purpose the eggs and embryos of four species were laid under contribution. Besides these results Mr. and Mrs. Eigenmann devoted some part of their time to the study of the osteology of the bluefish (*Pomatomus*), the flounder, and other forms in connection with their work on systematic ichthyology. They made a representative collection of the fishes native to Wood's Holl waters for comparison with the forms found in other regions and in the fish faunas of which they are interested.

Mr. W. S. Marshall, of the University of Pennsylvania, was engaged during the month of September in making a series of preparations of the brains of the common fishes to determine the variations in the form of the organ and the arrangement of the cranial nerves by macerating the whole in 20 per cent. nitric acid, which softens everything but the nerve tissue. Following a method which has given very good results in the hands of Mr. C. F. Hodge, it is believed that interesting and important results may be obtained through such a study of the configuration of the brain and the arrangement of the cranial nerves of fishes, which will supplement those obtained by Mr. Phillips by another method. This method of maceration also makes it possible to isolate the dermal trunks of the lateral nerves, which are very important in

connection with the system of lateral sense organs. These latter it is very important to study, as a knowledge of their function will doubtless enable us to understand to some extent how a fish is impelled to escape from its enemies through warnings sent in to the motor centers from this singular peripheral system of sense organs.

Mr. Marshall also collected a series of starfishes and crustaceans for purposes of dissection.

Special investigations upon the lateral system of sense organs of fishes were undertaken by students in the Boston marine laboratory at the suggestion of the writer. Two ladies, Miss Clapp and Miss Harris, worked on this subject, under the direction of Dr. C. O. Whitman. The former took up the study of the development of the lateral lines in the toad-fish (*Batrachus tau*), a form upon which the writer of this had made some studies in a similar direction. Miss Harris took up the study of the special differentiation of the three free rays of the pectoral of the Gurnards (*Prionotus palmipes* and *evolans*), upon the structure and anatomy of which Prof. H. A. Allen and the writer made some anatomical and histological investigations four years ago. Professor Allen also at that time undertook some physiological investigations. These organs in *Prionotus* are among the most singularly and highly developed known to occur in fishes. They are provided with very large nerve trunks, a specialized motor apparatus, and a most singular system of terminal sensory organs. Their function, there is reason to think, is tactile and may enable the animal to determine the presence of its favorite food on the bottom.

Mr. S. Watase, a fellow of Johns Hopkins University, continued his elaborate studies upon the development and anatomy of the king crab (*Limulus*) and the squid (*Loligo pealii*). Of these studies it is not too much to say that they are among the most beautiful and thorough ever carried out in America, and when completed and published will undoubtedly be regarded as classical. The masterly thoroughness and patience with which the details have been worked out under the microscope, the exquisite and careful finish of the drawings which illustrate those details, are only equaled by the insight of Mr. Watase into the comparative merits of his facts in reaching general conclusions.

Mr. Watase has obtained an abundance of material for the study of the development and anatomy of the king crab. He has confirmed the discovery of Drs. Brooks and Bruce as to the invagination of the median eyes from the under surface of the head and their migration through to the upper surface. He has also made important discoveries in the mode of innervation and structure of the lateral eyes, and has cleared up some of the intricate questions respecting their development. The central nervous system of the adult has also received a careful and thorough study at his hands. He has made an unrivaled collection of embryological and anatomical materials. All students will certainly await the publication of his results with interest.

His studies upon the early history of the germinal area of the squid are without doubt the most exhaustive yet undertaken, as he has been able to trace the origin of the individual cells and their relations to a median plane of symmetry which bisects the germinal area. This has been made possible by the clearness with which the phenomena of karyokinesis manifest themselves. Other aspects of the subject will also be dealt with by him, especially the phenomena of fertilization, the formation of polar cells, the development of the ciliated areas on the embryo, etc. The development of the eye will also form the subject of special treatment at his hands. The habits of the adults during the breeding season have also been studied by Mr. Watase.

The value of these studies on account of the economic importance of the squid as bait and as food is not to be lost sight of. They are an important article of food in China, very large quantities of an allied species being salted, dried, and shipped to that country annually from our west coast. On the eastern coast they are scarcely less valuable as bait to the New England fishermen.

Dr. Wm. Patten, of the Lake laboratory at Milwaukee, Wisconsin, spent part of June and July in the Fish Commission laboratory, collecting and studying materials for further work on the minute structure of the eyes of the king crab (*Limulus*) and other arthropods. He secured a large series of embryos for this purpose along the shores of the harbor, which will no doubt enable him to add essentially to the very important results which he has already obtained in this direction, and which have been published in the Mittheilungen of the zoological station at Naples and in the Journal of Morphology.

Mr. W. McM. Woodworth, representing Harvard University, during part of July and August took up the study of the planarians parasitic upon the gills of *Limulus*. For this purpose he secured a large suite of materials and made a series of careful studies upon the nervous system and general structure of these singular parasites. New results of great interest with respect to the structure of the nervous system of these organisms were obtained by Mr. Woodworth.

Dr. E. A. Andrews, a fellow in Johns Hopkins University, was engaged during July, August, and September in a series of investigations upon one of the gephyrean worms (*Phascolosoma*) and upon *Diopatra*, one of the common annelids. He also devoted some time to the study of the structure, the histology, and the physiology of digestion of *Phascolosoma*, and also its embryology. The development of the very remarkable ova of *Diopatra* occupied another portion of his time. A large number of finely executed drawings were made by him in the course of his work.

Mr. T. H. Morgan, another fellow in biology in Johns Hopkins University, devoted his attention to the study and collection of Ascidians or Tunicates. Of these he has investigated six genera in the laboratory during the summer, *Salpa*, *Botryllus*, *Amouræcium*, *Molgula*, *Appendicularia*, and *Perophora*. Mr. Morgan has been on a number of expedi-

tions with the steam launch and tow net to the vicinity of Gay Head and Penikese to collect living examples of *Salpa*, besides one trip on the U. S. Fish Commission schooner *Grampus* as far out as the Gulf Stream for the same purpose. The last of these expeditions was partially successful. The object of collecting this material is to get a basis for comparison with the life history of the simpler forms of Tunicates and to work out the precise method of the budding and development of the young *Salpa*, a problem to which Dr. Brooks has devoted much attention, as may be learned from the very important memoirs which he has published on the subject. Mr. Morgan has made sections of the reproductive organs and sexual products in relation to the parent of the other five genera for comparison with *Salpa*, and will doubtless reach important conclusions upon completing his studies.

Prof. W. K. Brooks, of Johns Hopkins University, Baltimore, has continued his extensive and elaborate studies upon the medusæ and hydro-medusæ of the Atlantic coast at the U. S. Fish Commission Station at Wood's Holl. Prof. Brooks's studies have hitherto been confined in the main to those upon the southern coast of the United States from Maryland to Florida and the West Indies, especially the Bahamas. During the 10 years of his work as director of the Chesapeake Zoological Laboratory of Johns Hopkins University he has accumulated several thousand sketches and beautifully finished studies from life of this group from materials obtained over the very wide marine area mentioned above. These results have enabled him to compare the northern and southern forms, for the first time at Wood's Holl, on the basis of a wider acquaintance with the different types ranging over this area than is probably possessed by any other student of these groups. Several common forms found about Wood's Holl, usually regarded as the same as the southern ones, have been found to represent allied but different species, with either a different habit of growth or a somewhat different life-cycle.

Professor Brooks has made studies of the life histories of the following genera of medusæ and hydro-medusæ: *Cyanea*, *Dactylometra*, *Mnemiopsis*, *Pinnaria*, *Pelagia*, *Hydractinia*, *Tubularia*, *Physalia*, *Campanularia*, *Margelis*, *Lafœa*, *Dipurina*, *Regmatodes*, *Clava*, and *Eudendrium*, all collected near the station. Not only have careful drawings of the adults of most of these been made, but studies of their life-cycles or metamorphoses and development have been carried out. Suites of very carefully preserved materials have also been collected for further investigation of the embryology, histology, and minute anatomy of these animals. The drawings by Dr. Brooks, illustrating the life-cycle and metamorphosis of the individual species, are not surpassed for accuracy and attention to details by any recent work, and can only be brought into comparison as respects the thoroughness and beauty of illustration with the classical monographs of Agassiz, Allman, and Haeckel.

Dr. Brooks accompanied the expedition of the U. S. Fish Commission

schooner *Grampus* to the Gulf Stream to obtain data respecting the existence of the tile-fish, which was so mysteriously destroyed in such inconceivably vast numbers a few years since. While the search for tile fish again proved fruitless, collections of *Salpa*, heteropods, pteropods, and *Sagitta* were obtained in fine condition, besides several well-preserved *Physaliæ* and *Discomedusæ*.

During these expeditions Dr. Brooks also experimented very successfully with entirely new methods of preserving such delicate organisms as jelly-fishes. The method, which is a very simple one, consists in adding glycerine to Perenyi's fluid until a solution is obtained of the specific gravity of sea water. In this the jelly-fish is killed. The specimen, after the killing is completed, is transferred to a mixture of alcohol and glycerin of the same specific gravity as the first; in this it is preserved, and remains flexibly transparent and preserves its form as well as its histological structure admirably. The results so far obtained show that the method will be a most useful and convenient one.

A complete series of the early stages of the small viviparous lamellibranch, *Sphærium sphericum*, was also obtained by Dr. Brooks from the fresh-water pools in the vicinity of Wood's Holl. Some interesting facts regarding the manner in which the young mollusk is nourished by and inclosed in capsules between the gills of the parent have been obtained by Dr. Brooks from the preliminary study of these animals.

Workers from other institutions have also availed themselves of the facilities afforded by the station for the collection of materials for class work. Among those who have been there for that purpose are Prof. S. F. Clarke, of Williams College; Prof. J. S. Kingsley, of the Indiana University, Bloomington, Indiana; Prof. Spencer Trotter, of Swarthmore College, Swarthmore, Pennsylvania; Professor Miller, of Princeton; Prof. H. N. Mateer, of Wooster University, Wooster, Ohio; Mr. W. S. Marshall, of the University of Pennsylvania, and Mr. Geo. Howard Parker, instructor in biology, Museum of Comparative Zoölogy, Harvard College, Cambridge, Massachusetts.

Substantial assistance has also been rendered the Marine Biological Station established at Wood's Holl by the efforts of citizens of Boston in giving the investigators and students connected with that institution facilities in collecting, in company with the naturalists of the U. S. Fish Commission, on the expeditions made with the steam-launch and the U. S. Fish Commission steamer *Fish Hawk*. In this way teachers and students who were not previously familiar with the methods used in deep-sea dredging were enabled to witness the most modern appliances in operation and obtain useful material not otherwise accessible. Similar courtesies were also extended by Commissioner McDonald to Professor Dwight, of Vassar College, and his pupils, who were engaged in scientific explorations and biological studies at Cottage City, Martha's Vineyard.

Summarizing, Johns Hopkins University was represented by five

workers; the University of Pennsylvania by three; Harvard University by five; Princeton College by three; Wooster University, Wooster, Ohio, by one; Swarthmore College by one. Eighteen workers therefore availed themselves of the facilities afforded by the laboratories of the U. S. Fish Commission during the season, these eighteen representing six well known institutions of learning. The Boston Marine Biological Laboratory, Williams College, the University of Indiana, Harvard University, Vassar College, Swarthmore College, Johns Hopkins University, and the University of Pennsylvania have obtained collections for biological work through the facilities offered by the U. S. Fish Commission. About thirty teachers and students availed themselves of these advantages.

Of the monographic work in the widest sense undertaken and carried on to a more or less advanced stage of completion, the work on the sturgeon and the iconography and life histories of the food-fishes is either well advanced or in progress. The proposed monography of the medusæ and the hydromedusæ by Prof. W. K. Brooks (for which he has been gathering materials for several years not only here but in many other localities) is the most extensive and, from a purely morphological view, perhaps the most important. The next are the two monographs by Mr. S. Watase on the squid and the king crab, which will vie with anything produced abroad as respects the thoroughness with which the work will be carried out. Finally, the work on the ascidians by Mr. Morgan, that on the worms by Dr. Andrews, and that on the oyster by Mr. C. F. Hodge, and by Dr. Brooks on *Sphærium*, will add four more monographs or papers of important economical or scientific value. Eight important monographs or papers at least may be expected to be the outgrowth, wholly or in part, of the work of some seven of the workers engaged in study in the laboratory of the U. S. Fish Commission during the season of 1888.

Sundry improvements, such as dividing the main laboratory in part into stalls for individual workers, have been proposed, so as to make it possible to have more shelf room for reagents, materials, and apparatus. A new self-regulating paraffin bath has been purchased for general use by the workers engaged in research requiring the use of the microtome. A more complete set of glassware, adapted to the requirements of modern biological research, is much needed for the laboratory, and will be added during the next year. These and minor changes in the arrangement of facilities, such as the extension of the system of aquaria now in use, will render the laboratory of the U. S. Fish Commission at Wood's Holl, with its means for obtaining materials by the aid of launches and steam-vessels, the most thoroughly equipped marine station in the United States. As it is, there is now no other place where marine life may be studied with such facilities as here, since the introduction of wooden and rubber pipe for conveying the sea water from the supply tanks to the aquaria. Furthermore, there is

no place where the development and life histories of species, such as the lobster, cod, bluefish, mackerel, and sea bass, can be more advantageously studied than in the hatching rooms connected with the laboratory of this station.

The Commissioner, Professor McDonald, has been engaged, during a considerable part of the time which he has been able to spare from his official duties, in devising improvements in the methods of displaying living objects in the aquaria under the best conditions. This has been accomplished by allowing the light to pass down through the water from above and cutting off the view from the upper surface entirely. This, with tastefully arranged rock work, algæ, polyps, and a limited number of fishes, gives picturesque effects of marvelous beauty, and also renders the organisms confined in the aquaria capable of being studied under conditions natural to them. Sea-anemones, with their flower-like disks of tentacles fixed to the rocks, active stickle-backs, the gorgeously colored sea bass, scup, crevalle, and mackerel swimming back and forth through the grottoes in these aquaria, make a combination of most beautiful objects, which have been sources of perennial interest and instruction to the many hundreds of visitors who have passed through the hatching rooms of the station during the past summer. These displays have also afforded the naturalists very valuable opportunities for studying some of the comical habits of the common denizens of the waters in the vicinity of the station. Some very important and significant habits have thus been made out as characteristic of given types. The tautog, for example, has the habit of lying over on its side, first digging out a bed for itself in the sand or gravel; here it rests as contented as a pig in a puddle till some unwary victim comes along to tempt the fish from his lair. Some such habit as this may have given rise to the flounders, which have unquestionably descended from fishes with an eye symmetrically placed on either side of the head.

The Commissioner has also been experimenting, with most promising results, with new methods of aëration, so as to maintain life in the aquaria without a change of seawater. The presence of the water supply in the tanks is utilized in such a way as to form an aërating apparatus which carries a stream of air divided into fine bubbles through some of the aquaria, from which the supply of water is entirely cut off. The water used in effecting aëration in this manner can be used to operate other overflow aquaria, or such as are fed by constantly renewed supplies of sea water. A plan such as this will make it possible to have marine aquaria operated at the Central Station at Washington, the aëration of the salt water being easily effected by the utilization of the supplies of fresh water used in the operation of fresh-water aquaria. This will make that station doubly valuable in conducting experimental work, and give increased interest to the display of fresh-water fishes, to which it will then be possible to add many marine forms for exhibition in the

living state. This may be made a most important display supplementar to the exhibits in the zoölogical garden to be established in Washingto under the direction of the Smithsonian Institution. The fresh-water an marine aquaria, the great national museums of art, science, medicin and anatomy, the great libraries, botanical and zoölogical gardens situ ated so near together, will thus doubtless become centers of great publi interest and afford a most useful educational influence in Washington

The adaptation of an aquarium for the convenience of the artist i delineating the fishes has also been devised by the Commissioner. A movable diaphragm of glass is suspended so as to make it possible t restrict at will the space in which a live fish is confined while bein sketched. This serves to keep the animal quiet in a narrow space, an enables the artist to work more confidently in catching details of forn and color. The same device will be used in conducting experiments i photographing the living fishes in the water.

It is most earnestly to be hoped that a continuance of the libera coöperation of Congress with the Fish Commission may be maintained in order that the present Commissioner, Prof. Marshall McDonald, ma be enabled to further develop the interests of practical fish-culture i America. The policy of the Commissioner is simply to continue in th line of work originally proposed by Professor Baird, and to call to hi aid, in the work of elucidating the economico-biological problems whic call for answers from time to time, the leading biologists of the countr This makes the maintenance of a great seaside laboratory near the fish ing interests of the country a necessity, if the fullest significance is t be given to the economical work which still remains to be carried ou The marine organisms which man uses as his food prey upon each othe and upon such living things as are not directly available as food for mai It thus comes about that when the life-history of any form used as foo is to be fully known, the habits, habitats, or natural history of hundred of forms which have no direct relation to man's wants must also b studied. This can nowhere be so well done as in a properly equippe and maintained seaside laboratory or zoölogical station, which shoul aim to achieve the preëminence so deservedly attained by the worl famous establishment founded by Professor Dohrn at Naples. Dr Dohrn, besides devoting a large private fortune to organizing his estab lishment, has had the assistance of the German and Italian Govern ments, and of that most enlightened and liberal-minded prince, the lat Frederick III, Emperor of Germany, while several learned societies an institutions have also rendered him other important aid. If individua enterprise, aided by some of the governments, princes, and academie of Europe, can take pride in pursuing biological investigation for it own sake and quite irrespective of any economic bearings it may have it is surely not too much to expect this great country to support re searches which have the most direct and immediate bearing upon th food-supply of a nation of fifty millions of people.

6.—NOTES ON ENTOZOA OF MARINE FISHES, WITH DESCRIPTIONS OF NEW SPECIES.

PART III.

ACANTHOCEPHALA.

By EDWIN LINTON, PH. D.,
Professor of Zoölogy in Washington and Jefferson College.

INTRODUCTORY NOTE.

The specimens which furnish the basis of the following notes were collected, for the most part, at the laboratory of the U. S. Fish Commission, Wood's Holl, Massachusetts, in the summers of 1886, 1887, and 1888.

So far as my observation extends, the only fishes that are much infested by the Acanthocephala are the striped bass (*Roccus lineatus*) and the flounders. In the latter I have found them abundant only in the common flatfish or mud dab (*Pseudopleuronectes americanus*). Even in the flatfish the occurrence of this parasite is by no means universal. I have often examined a lot of a dozen or more of these flounders and found Echinorhynchi in but two or three of them. A peculiarity of the Echinorhynchus (*E. acus*) of this flounder, however, is that when it does occur it is apt to infest the host in immense numbers. It is not an uncommon thing to find several hundred in a single host.

The striped bass is very commonly infested with *E. proteus*, and often with great numbers of this parasite. With these two exceptions I have found these entozoa of rather infrequent occurrence. The Selachians appear to be nearly exempt from them. In a former paper* I recorded *E. agilis* from the dusky shark (*Carcharhinus obscurus*), and in this paper a doubtful species from the sand shark (*Carcharias littoralis*). In each case there was but a single specimen. It may be observed with regard to the finding of entozoa in unlooked-for positions, that specimens may pass into the alimentary canal in the adult condition along with the proper host, and continue to live for some time within what is not the proper final host.

Nearly all the specimens which I have found in the body-cavities

* Report of Commissioner of Fish and Fisheries for 1886.

of fishes have been immature. In such positions they are usually inclosed in a membranous cyst, derived from the peritoneum of the host, and are provided with an extra epidermal investment which is often variously armed with spines. By a reference to figs. 54 and 74 of this paper it will be seen that this spine-bearing investment is something entirely distinct from the true cuticle of the adult. In *E. sagittifer* there is a smooth epidermal investment which is easily stripped off. The spines in this species are borne on the true cuticle. (Fig. 80, *k*.)

While it does not form a part of the plan of these notes to enter into details of structure, I have found it necessary in determining specific relations to make many series of sections, and have inserted a few sketches of the more characteristic features of the structure of the body wall of this somewhat anomalous group. In these researches I have incidentally confirmed many of Sæfftigen's observations on *E. proteus*, and have found homologous characters in *E. acus*, *E. attenuatus*, etc.

Systematic work in this group is attended with much difficulty, and I can not say that I am wholly satisfied with every identification which I have made in this paper. The older systematic literature contains only brief general descriptions of species, with usually no illustrations. It becomes a very perplexing matter, therefore, even in species of common occurrence, where there are no strongly marked specific characters, to refer them to old species.

Again, it is to be noted that but little systematic work among the entozoa of fishes has been done on this side of the Atlantic, and inasmuch as the hosts, in a large number of instances, differ specifically from their European representatives, it should not be a matter of great surprise if their parasites should likewise present differences.

I have endeavored to give in the descriptions and sketches of this paper the essential characters of the species discussed, whether regarded by me as new or referred to old species, so that subsequent workers in this little-cultivated field of research may not meet with the same difficulties I have encountered in determining species.

Following is a list of the species described in this paper, with their several hosts:

Parasite.	Host.
1. E. acus (adult)	Prionotus evolans, Lophius piscatorius, Gadus morrhua, Melanogrammus æglefinus, Pseudopleuronectes americanus, Paralichthys dentatus, Roccus lineatus, Limanda ferruginea, Cottus æneus.
E. acus (young)	Stenotomus chrysops.
2. E. thecatus, sp. nov	Roccus americanus.
3. E. attenuatus, sp. nov	Acipenser brevirostris.
4. E. pristis	Tylosurus caribbæus.
var. tenuicornis	Tylosurus caribbæus, Lobotes surinamensis.
5. E. incrassatus	Lophius piscatorius, Paralichthys dentatus, Pomatomus saltatrix.
6. E. agilis	Roccus americanus.
7. E. serrani	Serranus atrarius.
8. E. sagittifer	Cynoscion regale, Paralichthys dentatus, Pomatomus saltatrix, Serranus atrarius.
9. E. carchariæ	Carcharias littoralis.
10. E. proteus	Roccus lineatus, Cynoscion regale.

On account of the complicated muscular system of the Acanthocephala there is a decided tendency to contract unequally when placed in the killing fluid. In the case of *E. acus* I have succeeded in preserving specimens in the best condition for histological study by first placing them for a short time in fresh water, after which they may be transferred to any of the ordinary hardening fluids. Specimens may be killed in a weak solution of chromic acid, in which they continue to live for several hours in good condition for histological work. I have had excellent results also in the use of osmic acid.

Mr. V. N. Edwards, of Wood's Holl, Massachusetts, has rendered me valuable service in procuring specimens.

Order ACANTHOCEPHALA Rudolphi.

Genus ECHINORHYNCHUS Zoega.

ECHINORHYNCHUS ACUS Rudolphi.

[Plate I, figs. 1–11, and Plate VIII, figs. 89–90.]

U. S. F. C. Rept. 1886, pp. 492, 493, plate V, figs. 7–13.

This species was recorded in the paper referred to above from *Paralichthys dentatus*. I have referred to this species several finds of Echinorhynchi from a variety of hosts. These, while differing greatly in shape and size, agree closely in all essential characters.

Since my first paper was submitted I have noted the occurrence of this parasite on several occasions, as follows:

No.	Date.	Name of host.	No. of fish examined	No of Echinorhynchi.	Remarks.
	1886.				
1	Aug. 6	Prionotus evolans	1	1	Wood's Holl, Mass.
2	Aug. 6	Lophius piscatorius	1	9	Vineyard Sound, near Gay Head.
3	Aug. 8	Gadus morrhua	....	17	U. S. F. C. str. *Albatross*. Collected by Mr. Thomas Lee.
4	Aug. 8	Melanogrammus æglefinus	....	85	Do.
5	Aug. 10	Pseudopleuronectes americanus	1	76	Wood's Holl, Mass.
6	Oct. 4	Paralichthys dentatus	1	10	No. 1509, Block Island; collected by S. E. Meek, at Fulton Market, N. Y.
7	Oct. —	Roccus lineatus	....	85	Collected by S. E. Meek, at Fulton Market, N. Y.
8	Oct. —	Pseudopleuronectes americanus	1	85	No. 1525, S. E. Meek.
9	Oct. 13	...do	1	75	No. 1506, S. E. Meek.
10	Oct. —	...do	....	41	No. 1521, S. E. Meek.
11	Oct. 7	...do	....	192	Collected by V. N. Edwards, Wood's Holl, Mass.
	1887.				
12	July 21	Prionotus evolans	1	1	Wood's Holl, Mass.
13	Aug. 10	Pseudopleuronectes americanus	17	116	Do.
14	Aug. 10	Paralichthys dentatus	1	1	Do.
15	Aug. 29	Pseudopleuronectes americanus	1	42	Do.
16	Aug. 30	Paralichthys dentatus	4	160	Do.
17	Sept. 6	Limanda ferruginea	12	64	Do.
	1889.				
18	July 16	Pseudopleuronectes americanus	1	1	Collected by Dr. B. Sharp, Wood's Holl.
19	July 23	...do	14	Numerous.	157 from one host.
20	July 23	Cottus æneus	1	1	Specimen more slender than those from *P. americanus*, but resembles them in all essential points.
21	Aug. 8	Pseudopleuronectes americanus	1	621	Collected by V. N. Edwards.
22	Aug. 8	Limanda ferruginea	1	2	Do.

The proboscis in this species is, as a rule, linear, but sometimes is enlarged slightly at the base, and sometimes increases in size a little towards the apex. There are about 10 series of hooks visible on a side, or 20 in all, and 16 hooks, more or less, in a longitudinal row. The hooks are about .06^{mm} in length, stout, and strongly recurved. The proboscis is much smaller than the anterior part of the body, and is very commonly inclined obliquely or even at right angles to the axis of the body. In the latter case the body is prominently shouldered anteriorly. The proboscides were observed in some cases simply retracted, in others partly or completely inverted. The neck is so short as to be invisible when there is the slightest invagination of the body at the base of the proboscis. In some of the specimens from *Limanda ferruginea* a short, conical neck was seen. The proboscis sheath is one and a half to two times as long as the proboscis, and the lemnisci usually a little longer than the sheath.

The two testes are oblong, situated a little back of or near the middle of the body, and separated from each other by an interval somewhat less than the length of a single testis. They are usually distant from the remainder of the genitalia, which consist of a moniliform chain of about six prostatic glands and an elongated ejaculatory sac.

These parasites are abundant, especially in *P. americanus*, where the intestine is sometimes distended with them. In cases where several fish were examined at the same time, *e. g.* in No. 13, where 17 flounders were examined, by far the greater number of parasites obtained were found in the intestines of two or three of the hosts.

The following notes on color, etc., were made from observations on lot 13, from *P. americanus:* Color in general light orange-yellow; many, cream-yellow merging into light orange-yellow, with one or two spots of orange. In the lot of 116 Echinorhynchi three or four were a light lemon-yellow, one greenish-yellow, and one orange-yellow; one light orange in front, posterior half cream-color. Some were plump, and others were flat, thin, and flaccid. Some were curled up and transversely wrinkled, others elongated and straight. Some of the straight, flat, thin ones marked with transverse opaque blotches.

Upon being placed in fresh water for a short time these worms became distended,* while the color changed to light-cream, with a faint tinge of orange or lemon-yellow. One specimen, which in sea water was cylindrical and measured 20^{mm}, after lying in fresh water for 1 hour measured 48^{mm}, and 55^{mm} in 1½ hours more. Another, which in sea water was flat and thin and 26^{mm} in length, after being in fresh water for 1 hour measured 30^{mm} in length, otherwise but little changed except that it was plumper and the proboscis, which at first was retracted, afterwards protruded obliquely. A straight, thin, and flat specimen, 25^{mm} in length, was placed in Perenyi's fluid. In half a minute it shrunk to 12^{mm}, and was rather plump, rugose, and bluish-white in

* U. S. F. C. Report for 1886, page 508, plate v, figs. 10, 11.

color. Specimens transferred from fresh water to Perenyi's fluid suffered no change except to assume a bluish-white color. A plump specimen transferred from sea water to Perenyi's fluid showed no change except loss of color. A flat, thin specimen, 35^{mm} in length, transferred from sea water to 50 per cent. alcohol, shrunk to 19^{mm}, became plump, rugose, lost color slowly. A flat, thin specimen, 25^{mm} in length, transferred from sea water to chromic acid ½ per cent., changed its shape very slowly, and was rather active and uneasy for some time; in 15 minutes it had contracted to about 20^{mm}. A specimen 30^{mm} in length, transferred from fresh water to chromic acid ½ per cent., suffered scarcely any change.

It can be seen very easily from the foregoing that alcoholic specimens vary in their proportions according to the manner in which they have been preserved.

Some observations were made, by means of transverse and longitudinal sections, on the structure of the body wall of this species. It is not within the purpose of these notes, however, to enter into a discussion of the details of structure. The few sketches which I have appended, with their accompanying explanations, will give a good general idea of the arrangement of the various layers of the body wall. Saefftigen's excellent paper (*Zur Organisation der Echinorhynchen*)* leaves nothing to be added to a knowledge of the organization of the Echinorhynchi, except after the most painstaking and exhaustive anatomical research.

In addition to the foregoing specimens, all of which were obtained from the alimentary canal of their respective hosts, I have, on two different occasions, met with young Echinorhynchi in the body cavity of the scup (*Stenotomus chrysops*), which appear to be the young of *E. acus*.

On August 30, 1887, eight scup were examined; the only parasites found were two small Cestod cysts and a single male Echinorhynchus, all in the peritoneum. The Echinorhynchus, although found in the body cavity instead of in the alimentary tract, and smaller than mature forms, is not immature in structure. The genitalia are perfectly developed. Each testis is about 0.7^{mm} long and 0.26^{mm} broad. The prostate glands, seminal vesicle, etc., make a moniliform chain of six bodies as in the adult *E. acus*. The bursa was inverted but became quite evident when the specimen was placed in glycerine. The shape of the proboscis and the shape and disposition of the hooks agree with *E. acus*. The hooks are, however, nearly one-third smaller. The neck is short, conical, and unarmed; the body transversely roughened with irregular folds; proboscis slightly inclined to one side; color translucent bluish white with reflected light, yellowish with transmitted light. The specimen became somewhat longer and more slender after it was placed in alcohol. Length in alcohol, 6^{mm}; greatest diameter, 0.5^{mm}; length of

*Morphol. Jahrb., 1884.

proboscis sheath, 0.8^{mm}; diameter of sheath, 0.22^{mm}; diameter of proboscis, 0.2^{mm}; length of hooks, 0.046^{mm}.

On September 6, 1887, I examined ten or twelve specimens of scup. The entozoa found were a few Nematods and Cestod cysts and one female *Echinorhynchus*, all in the body cavity, attached to the peritoneum where they were surrounded by a thin membranous covering.

The specimen is about 7^{mm} in length and .4^{mm} in diameter. The body cavity is filled with globular masses not yet differentiated into ova. The outline of the proboscis and the arrangement and number of the hooks correspond with *E. acus.* There is, however, this peculiarity: the hooks are surrounded at the base by a raised collar somewhat as in *E. thecatus.*

ECHINORHYNCHUS THECATUS, sp. nov.

[Plate II, figs. 12-22.]

The following description is based on alcoholic specimens collected by Prof. S. E. Meek, at Fulton Market, New York, and received by me October 20, 1886. There were eighty-seven specimens in the lot, the longest females about 20^{mm} in length, the shortest males about 5^{mm}.

Body cylindrical, usually arcuate, smooth, tapering slightly for a short distance at anterior end, but little tapering posteriorly, sometimes slightly enlarged and rounded at posterior end. Neck short, conical, unarmed. Proboscis fusiform, often oblique to axis of body, with about twelve series of hooks, about six visible on a side in a single spiral. Ventral hooks strongly recurved; dorsal, arcuate, all becoming smaller near base of proboscis. Each hook surrounded by a thin, transparent sheath, which incloses the base and about half the length of the hook. Proboscis sheath longer than proboscis. Lemnisci very long, slender, reaching to the second testis in the male, but often doubled on themselves. Testes two, median, contiguous, followed by a botryoidal mass of about six prostatic sacs. These are succeeded by a large ejaculatory duct. The bursa was retracted in all cases, but could be plainly seen through the walls of the body.

The following measurements of two alcoholic specimens, a male and female, slightly compressed, are given for purposes of comparison:

Measurements.	♀	♂
	mm.	*mm.*
Length	18.00	12.00
Diameter of body, anterior	0.60	0.60
Greatest diameter	1.40	1.30
Diameter near posterior end	0.90	0.54
Length of neck	0.26	0.26
Diameter of proboscis, apex	0.20	0.22
Diameter of proboscis, middle	0.30	0.30
Diameter of proboscis, base	0.26	0.23
Length of proboscis	1.00	0.80
Length of sheath	2.45	1.90
Diameter of sheath	0.38	0.36
Length of lemniscus	5.00	4.20
Diameter of lemniscus	0.08	0.08

Length of one of larger hooks, 0.066^{mm}; breadth at base, 0.026^{mm}; length of chitinous (?) sheath, 0.036^{mm}; breadth of same at outer extremity, 0.027^{mm}; length of ova, 0.097^{mm}; breadth 0.019^{mm}.

Two lots of these Echinorhynchi were received, one containing 87 and the other 4 specimens. The first lot was from the stomach and intestine, the second from peritoneum and ovaries of their host.

Habitat: *Roccus americanus*, Long Island shore; collected by Mr. S. E. Meek, Fulton Market, New York, October, 1886.

ECHINORHYNCHUS ATTENUATUS sp. nov.

[Plate III, figs. 23 to 30.]

The following account is based on a few alcoholic specimens given me by Dr. B. Sharp. They were obtained from the intestine of a sturgeon (*Acipenser brevirostris*), Wood's Holl, Massachusetts, July, 1889. The specimens were said to have been numerous in the host. As no color notes were recorded they were probably whitish or yellowish white, the color most common in the entozoa. The females are about 25^{mm}, the males 12^{mm} in length; habit of body slender; greatest diameter near anterior end, attenuate posteriorly, slightly so anteriorly; frequently swollen on dorsal side at thickest place; body smooth, but sometimes with undulating outline, arising from a knotted appearance of the body; neck very short, conical; proboscis cylindrical, implanted somewhat obliquely; hooks of proboscis rather small and slender, deeply immersed in the tissues of the proboscis, strongly recurved, basal supports broad resembling those of *E. acus* but not so massive; about fourteen spiral series of hooks, ten or twelve visible on a side; lemnisci not seen satisfactorily, but apparently slender and a very little longer than the proboscis sheath; testes long, elliptical, distant from each other about the length of one, and the same from the anterior ot the prostate glands. The latter are six in number, making a moniliform chain much as in *E. acus*. Copulatory bursa not seen extended but evident in specimens made transparent.

The dimensions of a female specimen were: Length, 20^{mm}; greatest breadth, 1.75^{mm}; breadth at anterior end, 0.6^{mm}; at posterior end, 0.5^{mm}; length of proboscis, 0.8^{mm}; diameter, 0.32^{mm}; length of neck, 0.16^{mm}; length of sheath, 1.5^{mm}. The maximum length of the specimens submitted to me was 32^{mm}.

The character of the hooks is shown in the sketches appended to this report.

Longitudinal sections through the tumid anterior portion of one of these Echinorhynchi show that the space occupied elsewhere by the subcutaneous vascular layer of the body wall is here enlarged into a cavity filled by a fine granular homogeneous substance. The nerve ganglion is situated a little in front of the middle of the proboscis sheath.

ECHINORHYNCHUS PRISTIS Rudolphi.

[Plate IV, figs. 31 to 38.]

Rudolphi, Entoz. Hist., II, 299; Synopsis, 75, 333, 672. Westrumb, Acanthoceph., 32. Dujardin, Hist. Nat. des Helminth, 534. *E. pristis* Rud.? Wedl., Sitzungsb. d. kais. Akad. d. Wissensch., XVI, 402 and 408, tab. II[b], 10. Diesing, Syst. Helminth, II, 48; Revision der Rhyng., p. 750.

For older literature see Dies. Syst. Helm. Compare also *E. lateralis* Molin, Sitzungsb., d. kais., Akad. d. Wissensch., XXXIII, 295; Denkschr. d. k. Akad., XIX, p. 269, tab. VIII, fig. 13.

The description of this species, as quoted by Dujardin from Rudolphi, is as follows:

Body red or roseate, filiform; length, from 18 to 76^{mm}; breadth, 1.12^{mm} (Rud. *Entoz.*), or 0.56^{mm} (Rud. *Synops.*), cylindrical, a little swollen at some distance from the proboscis, and armed in front with a dozen rows of hooks, which are reddish, oblique, thick, and triangular, with a length of 6.75^{mm} in a specimen of 76^{mm}. Proboscis linear, straight, white, 2.25^{mm} in length, armed with thirty to forty transverse rows of hooks; neck, none.

Three lots of Echinorhynchi, two from a silver gar (*Tylosurus caribbæus*) and one from *Lobotes surinamensis*, have given rise to much perplexity in attempting their identification. Two well-marked forms are represented, which, however, have many characters in common with each other as well as with *E. pristis* Rud. and *E. lateralis* Molin. Three of these specimens agree sufficiently well with *E. pristis* to allow of their being placed, at least provisionally, under that species. The others from *Tylosurus* and those from *Lobotes* I have referred to the variety *tenuicornis*.

There is an element of doubt in this disposition of the specimens from the gar, which the following statement of fact will make plain. The two lots were from the same individual host. One lot, comprising three females and one male, was found in the intestine; the other, comprising two females and five males, was found in the rectum. The males of the two lots are plainly specifically identical. One of the females of the second lot has lost the proboscis and can not be compared with the others satisfactorily. The three females belonging to the first lot have long, slender, and moderately clavate proboscides, which are armed with about forty transverse spiral series of hooks, of which twelve or more may be seen in a single spiral on one side. All of the other specimens, including the males of both lots and the one female of the second lot, have smaller linear proboscides, which are armed with about twenty transverse spiral series of hooks, about six visible on a side in each spiral. The specimens from *Lobotes* agree closely with the latter form.

One of the females, which I have referred to *E. pristis*, yielded the following measurements while living; the specimen was slightly compressed: Length, 12^{mm}; length of proboscis, 2.60^{mm}; diameter of proboscis, apex 0.40^{mm}, base 0.26^{mm}; length of neck, 0.40^{mm}; diameter of neck in

front, 0.30^{mm}; diameter of body, anterior, 0.46^{mm}; greatest diameter of body, 0.80^{mm}; diameter near posterior end, 0.24^{mm}; length of proboscis sheath, 4^{mm}.

In this specimen there are about forty spiral series of hooks on the proboscis, twelve to fourteen hooks visible in a single spiral, and about twelve longitudinal rows visible on a side. These hooks are, for the most part, rather stout, sharply recurved and appressed, 0.05^{mm} in length near middle of proboscis, and 0.08^{mm} near the apex. On the dorsal side of the proboscis the hooks are smaller than they are on the ventral, and arcuate. There is a single circle of prominent arcuate hooks at the base of the proboscis, surrounding it somewhat like a spiny collar. These measure 0.08^{mm} in length. In front of the widest part of the body there are a few sagittate or triangular spines scattered rather sparsely over the surface. The length of the longest of these is about 0.08^{mm}, the breadth 0.04^{mm}. The proboscis in the alcoholic specimen is reflected nearly at right angles to the body and but slightly curved. The body is gently arcuate, with very numerous and uniform corrugations. The outline is linear, gently tapering posteriorly. The posterior end is oblique, narrowing abruptly, with the genital aperture about 0.016^{mm} from the end. The greatest breadth of the body is found about 2^{mm} back of the base of the proboscis. The neck is smooth, short, and conical. The length of the proboscis sheath in an alcoholic specimen was found to be over 5^{mm}. The lemnisci appear to be about the same length as the sheath. The ova measure 0.06^{mm} in length in alcoholic specimens.

The specimens while living were faintly tinged with orange, and one of them had a bright yellow patch adhering like a cap to the posterior end. The maximum length of the alcoholic specimens is 20^{mm}.

Habitat: *Tylosurus caribbæus*, intestine, Wood's Holl, Massachusetts, July 27, 1886.

Variety TENUICORNIS.

[Plate IV, figs. 39–41, and Plate V, figs. 42–53.]

The specimens which I have referred to this variety are five males and one female from the rectum of *Tylosurus caribbæus*, and one female and one male from the intestines of *Lobotes surinamensis*. The variety is based on the character of the proboscis, which is provided with about half as many hooks as that of *E. pristis*.

The following measurements were made on living specimens:

Measurements.	No. 1 ♀	No. 2 ♂	No. 3 ♂
	mm.	*mm.*	*mm.*
Length	11.60	7.40	10.20
Length of proboscis	1.40	1.40	1.70
Length of neck	0.26	0.24	0.10
Diameter of body, anterior	0.34	0.30	0.26
Greatest diameter of body	0.66	0.64	0.57
Diameter near posterior end	0.26	0.28	0.24
Length of proboscis sheath	2.20	2.00	2.50

Nos. 1 and 2 are from *Tylosurus;* No. 3 is from *Lobotes.*

No. 2 is the single female individual whose proboscis agrees with those of the male specimens. There are about twenty spiral series of hooks. The hooks on the dorsal side are about 0.04^{mm}, and those on the ventral about 0.07^{mm} in length. About seven hooks can be counted in each spiral on a side. The hooks agree closely in form and nearly in size, though not in number, with those of the first group. The anterior part of the body is armed with a few scattering sagittate or triangular spines, as in the others. The genital aperture of No. 1, as in those typical of the species, is a short distance from the posterior end, and appears to be stellate. This latter feature is one of the specific characters of Molin's *E. lateralis.* It was not observed in the others.

The males are smaller than the females. The two testes are oblong-elliptical. In one specimen they measured 0.9^{mm} and 0.7^{mm} in length, respectively, the anterior being the longer. The diameter of each was about 0.36^{mm}. The testes lie close together, one following the other, and are succeeded by the voluminous prostate glands and seminal receptacle. All these organs have a rich golden-brown color in the alcoholic specimens.

In the preserved specimens the bodies of the males are strongly arcuate, and the proboscides have a tendency to assume the shape of an interrogation point. As in the females, the anterior part of the body for a distance of 1 or 2 millimetres is armed with a few sagittate or triangular spines.

Two of the specimens from *Tylosurus* were bright orange-red in life, and the others were faintly tinged with orange. The red color appeared to be due to red globules in the fluid contents of the subcutaneous vascular system.

The lemnisci are at least as long as the proboscis sheath; in some of the males they are longer.

The length of the female specimen from *Lobotes* was 13^{mm} in life; length of proboscis, 1.24^{mm}; length of longest hooks, 0.08^{mm}; length of proboscis sheath, 3^{mm}; length of sagittate spines on anterior part of body, 0.08^{mm}. The color of the female from *Lobotes* was yellowish-white. At the distance of 1.4^{mm} from the neck on the dorsal side there was an oval, orange-colored spot, 0.08^{mm} in diameter. The proboscis and anterior fourth of the body of the male was bluish-white; from the base of the proboscis sheath to the middle of the body, pinkish-white; from the middle of the body to the posterior fourth, greenish-yellow; the posterior fourth, canary-yellow.

Habitat: *Tylosurus caribbæus*, rectum, Wood's Holl, Massachusetts, July 27, 1886; *Lobotes surinamensis*, Newport, Rhode Island, August 3, 1887.

ECHINORHYNCHUS INCRASSATUS Molin.

[Plate VI, figs. 54 to 69*a*.]

Molin, Sitzungsber. d. k. Akad. XXXIII, page 294; Denkschr. d. k. Akad. XIX, pages 260–262, tab. VIII, fig. 1.

Some immature specimens, two from the peritoneum of the angler (*Lophius piscatorius*), several from the peritoneum of the common flounder (*Paralichthys dentatus*), and one from the peritoneum of the bluefish (*Pomatomus saltatrix*), appear to be the young of this species.

The specimens from *Lophius* are broadly fusiform. The proboscis is stout, thickened near the base, from which point it tapers gradually towards the apex and abruptly towards the base. The hooks near the base are slender, falcate, pointed; near the middle becoming abruptly much larger, broader, and thicker, more strongly recurved and provided with elongated basal supports, as long or even longer than the hooks themselves; towards the apex the hooks are like the median hooks in shape but not quite so large. There are about ten spiral series of hooks, the five basal series small, the remainder large. About seven hooks can be seen on a side in a single spiral. Sheath two and a half times length of proboscis. Neck conical, smooth. Body behind neck inflated, when compressed somewhat rhomboidal, for a distance which is a little greater than the length of the sheath. In one of the specimens this part of the body was thickly covered with small spines. In the other specimens the spines were absent, evidently because the epidermis which bears them had been stripped off. Behind the inflated portion the body is cylindrical. The cylindrical part is somewhat less than one-half the entire length of the specimen, and its rounded extremity is armed with very small sagittate spines.

One of the specimens was evidently a young male. In the posterior, cylindrical part of the body, one of the testes has made its appearance a short distance back of the sheath, and what appears to be the other near the posterior end of the body. These rudimentary genitalia lie surrounded by large undifferentiated nucleated cells, inclosed in a suspensory ligament, which is attached to the base of the proboscis sheath. Two large masses of nucleated cells were observed lying one on each side of the sheath and occupying the place of lemnisci. These nucleated cells range from 0.02^{mm} to 0.06^{mm} in diameter. In one of the specimens the proboscis was partly inverted; the posterior end was also partly inverted; the genitalia in this specimen were rudimentary and appeared to be those of a female.

A small Echinorhynchus was found in the peritoneum of a bluefish, which I have likewise referred to this species. The proboscis was invaginated, but the outline of the hooks was distinct. There were about five series of relatively small, slender hooks at the base of the proboscis, with variously forking basal supports. (Figs. 69 and 69*a*.) These were followed immediately by very large median hooks, becoming a little

smaller toward the apex of the proboscis. The anterior part of the body was covered with scale-like spines, each with a midrib somewhat like that of a small leaf. Length of slender basal hooks, 0.08^{mm}; length of large median hooks, about 0.13^{mm}; length of fusiform proboscis, 1^{mm}; length of sheath, 2^{mm}; length of dermal spines, 0.036^{mm}.

One of the specimens from the "angler" gave the following measurements while living: Length, 5^{mm}; length of proboscis, 0.8^{mm}; diameter of proboscis at base, 0.28^{mm}; near base, at widest part, 0.34^{mm}; at apex, 0.22^{mm}; length of proboscis sheath, 2^{mm}; diameter of inflated part of body, compressed, 1.7^{mm}; diameter of posterior part, 0.6^{mm}; length of cylindrical part of body, 1.88^{mm}; length of largest hooks, 0.1^{mm}; length of dermal spines, 0.035^{mm}; length of caudal spines, 0.027^{mm}.

The shape of the proboscis is similar to that of *E. proteus*, but the median hooks are larger and the extremities of their basal supports not forked. There is also a more abrupt transition from the smaller basal to the larger median hooks than is the case in *E. proteus.*

These specimens agree closely with *E. incrassatus*, the principal difference being the presence of spines on the body. The spinose epidermis, characteristic of many immature forms of Echinorhynchi, seems to be frequently lost in the adult, and too much importance, therefore, should not be given to it as a specific character, when immature forms alone are under consideration.

Habitat: *Lophius piscatorius*, peritoneum, July 31, 1885; *Paralichthys dentatus*, July 6, and *Pomatomus saltatrix*, July 26, 1889, Wood's Holl, Massachusetts.

ECHINORHYNCHUS AGILIS Rudolphi.

[Pl. VII, figs. 70 to 72.]

U. S. F. C. Rept. 1886, pp. 490–492, pl. V, figs. 1 to 6.

In the report cited above I have noted the occurrence of this parasite in the common eel (*Anguilla rostrata*) intestine and in the dusky shark (*Carcharhinus obscurus*) stomach.

On October 20, 1886, I received from Prof. S. E. Meek, then employed in the biological laboratory of Mr. E. G. Blackford, at Fulton Market, New York, five specimens of this Echinorhynchus from the intestines of the white perch (*Roccus americanus*), associated with *E. thecatus.* The males in this lot are about 6^{mm} and the females about 8^{mm} in length.

ECHINORHYNCHUS SERRANI.

[Plate VII, figs. 73 to 79.]

The following description is based on a single immature specimen from the peritoneum of the sea bass (*Serranus atrarius*):

Body linear, gradually attenuate posteriorly, more abruptly attenuate anteriorly. Proboscis with seven or eight hooks visible in single spiral on one side, sixteen in longitudinal series. Hooks large, espe-

cially the median and anterior ones, which are broad, stout, and strongly recurved, with broad basal supports as long, or even longer, than the hook. Basal hooks more slender than median and anterior hooks, not so sharply recurved, and with shorter or, in some, with bifurcating basal supports (fig. 76). Length of longest hooks about 0.116^{mm}. Sheath twice the length of proboscis; lemnisci slender, not so long as the sheath.

Measurements.	Millimetres.
Entire length	14.00
Breadth at widest part	1.08
Length of proboscis (estimated)	1.20
Length of sheath	2.40

The anterior part of the body as far back as the base of the proboscis sheath was thickly beset with flat, appressed, scale-like spines. The thin membranous investment which bore these spines covered the entire body. It was partly removed during the examination of the specimen. From the manner in which it separated from the cuticle of the specimen I am inclined to interpret it as a character which is incidental to the encysted condition of the worm, and not to be regarded as an adult characteristic. The specimen is immature, but appears to be a female.

Habitat: *Serranus atrarius*, peritoneum, Wood's Holl, Massachusetts, September 3, 1885.

ECHINORHYNCHUS SAGITTIFER Linton.

[Plate VII, fig. 80.]

U. S. F. C. Rept. 1886, pages 493–496, plate VI, figs. 1 and 2.

The following captures of this parasite have been made since the report cited above was submitted.

Date.	No. of Echinorhynchi.	Name of host.
July 30, 1886	1	Cynoscion regale.
Aug. 10, 1887	2	Paralichthys dentatus.
Sept. 2, 1887	7	Do.
July 6, 1889	25	Do.
July 10, 1889	15	Do.
July 9, 1889	1	Pomatomus saltatrix.
July 10, 1889	1	Do.
July 15, 1889	4	Do.
July 10, 1889	1	Cynoscion regale.
July 26, 1889	1	Pomatomus saltatrix.
July 30, 1889	1	Serranus atrarius.
Aug. 19, 1889	2	Cynoscion regale.

These specimens were all found in the body cavities of their hosts, commonly in the mesentery and always inclosed in a thin, transparent membranous envelope. In some of the smaller specimens the rows of the spines on the body are poorly developed, but in all the larger specimens there are about twenty transverse rows of sagittate spines.

In fig. 80 a view of a longitudinal section of the body at the base of the proboscis sheath is given. The most obvious difference between these sections and those of adult Echinorhynchi appears to be the absence of distinct canals in the subcuticular layer.

ECHINORHYNCHUS CARCHARIÆ.

[Plate VII, figs. 81 and 82. Plate VIII, figs. 83 and 84.]

Proboscis with about ten hooks visible on a side in a single transverse row, following one of the spirals, and about fourteen in longitudinal series. Hooks rather long, stout, sharp, strongly recurved, with bases as long as the spinous part. Neck conical, unarmed, nearly as long as proboscis. Sheath about twice as long as proboscis; lemnisci about two-thirds the length of the proboscis. Body linear, tapering very gradually from about the middle to the posterior end, and slightly tapering near the anterior end.

This description is based on a single specimen. The Echinorhynchus was not noticed at the time of collecting, but was found afterwards in a vial in which cysts from the walls of the stomach and intestine of a sand shark (*Carcharias littoralis*) had been placed.

The proboscis was retracted and partly inverted so that neither the number and arrangement of hooks nor the outline of the proboscis could be made out with certainty. The surface of the specimen in glycerine appears crackled or mottled, a feature which is apparently due to the subcutaneous, reticulated vascular system. The specimen is a female and contains numerous fusiform embyros scattered through the body cavity along with several oval, granular bodies (fig. 84). At the posterior end of the body the uterus persists as a narrow oviduct which is packed with fusiform embryos (fig. 83).

The following measurements are taken from the specimen in glycerine slightly compressed.

Measurements.	Millimetres.
Length	22.00
Length of neck	.80
Length of proboscis	.80
Diameter of proboscis at base	.30
Length of longest hooks	.06
Length of sheath	1.60
Diameter of sheath	.36
Length of lemniscus	1.00
Breadth of lemniscus	.40
Diameter of body, anterior end	1.00
Diameter of body, posterior end	1.[illegible]0
Greatest diameter of body	1.70
Length of embryos	.07
Diameter of embryos	.02
Diameters of oval granular bodies	.09 .06

The specimen may come from the intestinal tract, although, if such is the case, I can scarcely see how it could have been overlooked. At the time of collecting I have always carefully separated those entozoa

which occur in the alimentary tract from those which are encysted or in the body cavity. The fact that the worm contains the characteristic fusiform embryos of the order points to but one conclusion, that if it was encysted it must have migrated from the alimentary tract to its place of lodgment.

The specimen bears some resemblance to *E. acus*, but on account of the smaller number of hooks, the evident neck, and the outline of the anterior part of the body, I have decided to refer it to a new species.

Habitat: *Carcharias littoralis*, Wood's Holl, Massachusetts, August 2, 1886.

ECHINORHYNCHUS PROTEUS Westrumb.

[Plate VIII, figs. 85 to 88.]

U. S. F. C. Rept. 1886, pp. 496, 497; plate VI, figs. 3 to 5. A. Sæfftigen, Morphol. Jahrb, 1884; plates III to V, anatomy. Carl Baltzer, Arch. f. Nat., 1880, I; plates I and II.

Since the paper cited above was handed in for publication I have obtained this parasite on the following occasions. The host in each case was the striped bass (*Roccus lineatus*):

No.	Date.	Number of fish examined.	Number of Echinorhynchi obtained.
1	Aug. 12, 1886	One	One.
2	Aug. 18, 1886	One	Three.
3	Aug. 31, 1886	One	Five.
4	July 13, 1887	One	Three.
5	Aug. 18, 1887	One	Eight hundred.
6	July 10, 1889	One	One.
7	Aug. 3, 1889	Three	Numerous in each.
8	Aug. 14, 1889	Seven	Several in each.

I have also had sent to me for identification by the U. S. Fish Commission two lots of *E. proteus* from *R. lineatus*, collected by Prof. S. E. Meek at Fulton Market, New York. The fish came from the coast of southern New England.

On July 15, 1889, I examined the viscera of eighteen squeteague (*Cynoscion regale*), in the intestine of one of which were two specimens of *E. proteus*. The heads were imbedded in the intestinal walls. The color of the body was a pale rusty yellow.

These parasites were found in the rectum of their hosts. In the majority of instances they had penetrated the muscular walls of the intestine, and the proboscides, protruding into the body cavity, had become the nuclei of cysts covered with a connective tissue layer, overlaid by a fold of the peritoneum, and containing a yellowish-brown, waxy secretion.

The adult of this form is readily recognized by its fusiform yellow or orange-colored body, slender filiform neck, surmounted by a thin membranous bulla.

The following details were taken from specimens belonging to lot No. 5, collected August 18, 1887:

One of the largest females afforded in alcohol the following measurements: Length of body, 18^{mm}; neck, 5^{mm}; proboscis, 1^{mm}; entire length, 25^{mm}; diameter of body, anterior, 2^{mm}; diameter of neck, 0.34^{mm}; diameter of bulla, 1.6^{mm}; diameter of inner core of neck, modified proboscis sheath, 0.2^{mm}; length of ovum, 0.08^{mm}; breadth, 0.011^{mm}.

A few males were observed, each with bursa everted, and with the slender neck expanding at the apex into an elliptical head filled with granular material (fig. 88). The length of these males was about 6^{mm}. Other males were found which had the normal shape of the species; body straight, long-fusiform; neck slender, cylindrical, expanding into a thin-walled bulla immediately behind the proboscis.

The length of one of the males was 16^{mm}; testes 0.6 to 0.7^{mm} in length, 0.26^{mm} in width.

The proboscis in this species is, when fully everted, somewhat fusiform, cylindrical at base, swollen in front of middle. A typical proboscis had the following dimensions: Length, 1^{mm}; diameter at base, 0.27^{mm}; diameter in front of middle point, 0.33^{mm}; diameter at apex, 0.13^{mm}. The hooks on the swollen part of the proboscis and towards the apex are stout, with a long bifid basal support. Behind the swollen part the hooks are more slender, conical, arcuate, with short bifid base.

A young male Echinorhynchus, which I take to be *E. proteus*, was found in the peritoneum of *Paralichthys dentatus*, Wood's Holl, September 2, 1887.

The proboscis was partially inverted. The hooks near the base, slender, slightly recurved, with bifid basal supports; those near the apex, broader, more abruptly recurved, basal supports also bifid. Proboscis sheath, long, slender, linear, rounded and slightly swollen posteriorly, enlarging slightly a short distance from anterior end. Lemnisci short, inserted near the base of the proboscis sheath. Anterior part of the body constricted, somewhat inflated near the proboscis, but not globular as in adult.

Length, 6.25^{mm}; length of proboscis, about 0.74^{mm}, 0.46^{mm} of which is inverted; length of sheath, 2.6^{mm}; length of testis, 0.3^{mm}.

The elongated proboscis sheath of this young specimen suggests the anterior part of the adult, which, after it is imbedded in the tissues of the host, becomes reduced to a filiform neck in which the sheath forms a central core.

The plates here numbered I to VIII follow page 542 and are there numbered LIII to LX.

EXPLANATION OF PLATES.

PLATE I.

Echinorhynchus acus, Rudolphi.

FIG. 1. Specimen from *Prionotus evolans;* portion of proboscis magnified about 200 diameters.
FIG. 2. Posterior end of male, lateral view of bursa, × 24.
FIG. 3. Terminal view of bursa, × 24.
FIG. 4. *a*, Ovarian mass, and *b*, ovum of a specimen from *Pseudopleuronectes americanus;* × 200.
FIG. 5. Embryos from same, × 200.
FIG. 6. Hooks from proboscis, from same, × about 200 diameters.
FIG. 7. Hooks from proboscis of specimen from *Melanogrammus æglefinus*, × 200.
FIG. 8. *a*, Ovum; *b*, embryo from same; × 200.
FIG. 9. Longitudinal section of proboscis sheath of specimen from *P. americanus; a*, outer muscular wall; *b*, inner muscular wall; *c*, nerve ganglion. The ganglion is situated a little back of the middle of the proboscis sheath; specimen killed with osmic acid, and stained with Bömer's hæmatoxylon; × 225.
FIG. 10. Transverse section of body wall; *a*, layer of longitudinal muscle fibers; *b*, layer of circular muscle fibers; *c*, longitudinal canals of the subcuticula; *e, f*, granular and fibrous layers of the subcuticula; *g*, vascular radial layer of the subcuticula; *h*, nuclei of the vascular layer; osmic acid and borax carmine preparation; × about 300 diameters.
FIG. 11. Transverse section through proboscis sheath and lemnisci, with two portions of the body wall. The difference in thickness in different parts of the circumference of the same section, here shown, is characteristic of the anterior region of the body. *a,a*, longitudinal muscle layer, enveloping the lemnisci (*e, e*) and forming the mantle of the lemnisci; *b*, outer, and *c*, inner muscular wall of the proboscis sheath; *d*, retractor muscle of the proboscis; *e, e*, mantle of the lemnisci, *f, f*, lemnisci; *g, g*, longitudinal canals of the lemnisci; *h, h*, longitudinal canals of the subcuticula; *i, i*, longitudinal muscle layer of the body wall; *k, k*, circular muscle layer; *l, l*, vascular (radial muscle) layer of subcuticula; *m, m*, cuticle; *n, n, o, o*, granular and fibrous layers of subcuticula. There are both circular and longitudinal fibers in these layers; osmic acid and Czoker's cochineal preparation; × about 375 diameters.

For longitudinal section of body wall and nerve ganglion see plate VIII, figs. 89 and 90.

Sketches by the author.

PLATE II.

Echinorhynchus thecatus, sp. nov.

FIG. 12. Optical section of a male specimen, rendered transparent by potassic hydrate, × about 27 diameters; *a*, sheath; *b, b, b*, lemnisci; *c*, retractor muscles of sheath; *d, d*, testes; *e*, prostatic glands; *f*, vas deferens; *g*, ejaculatory duct; *h*, bursa.
FIG. 13. Proboscis, × about 40 diameters.
FIG. 14. *a*, sheath, and *b, b*, lemnisci isolated, × about 14 diameters.
FIG. 15. View of lateral longitudinal subcutaneous vessel with its immediate branches. Specimen treated with potassic hydrate.
FIG. 16. Hook with theca after lying 18 hours in a strong solution of potassic hydrate, × about 200.
FIG. 17. Hook from ventral, *i. e.*, concave, side of proboscis, × 200.
FIG. 18. Hooks from dorsal, *i. e.*, convex, side of proboscis, × 200.
FIG. 19. Hook from ventral side of proboscis, near base, × 200.
FIG. 20. Hook from dorsal side of proboscis, after lying 24 hours in strong solution of potassic hydrate, × 200.
FIG. 21. Embryo, treated with potassic hydrate, × 200.
FIG. 22. Male with bursa everted and proboscis partly invaginated, × about 8 diameters.

Sketches by the author.

PLATE III.

Echinorhynchus attenuatus, sp. nov.

FIG. 23. Optical section of male; specimen in glycerine, × 4½ diameters.
FIG. 24. Anterior portion of proboscis, × about 200 diameters.
FIG. 25. Hooks isolated, somewhat more highly magnified.
FIG. 26. Portion of surface of proboscis treated with potassic hydrate.
FIG. 27. Longitudinal section of body wall stained with borax carmine, magnified about 350 diameters; *a*, cuticle; *b*, *c*, granulo-fibrous layers of subcuticula; *d*, vascular layer of subcuticula; *e*, circular muscle layer; *f*, longitudinal muscle layer; *g*, lumen of vessel of vascular layer; *h*, intra-fascicular substance of the longitudinal muscle layer with nucleus.
FIG. 28. Longitudinal section of anterior tumid portion of body wall, borax carmine stain, magnified about 270 diameters; *a*, cuticle; *b*, granulo-fibrous layers of subcuticula; *c*, vascular layer of subcuticula here reduced to small dimensions, its place being occupied by the homogeneous granular substance *d*, which fills the space between the vascular layer and the circular muscle layer, and gives rise to the anterior tumidity characteristic of this species; *e*, circular, and *f*, longitudinal muscle layers; *h*, *h*, nuclei of longitudinal muscle layer.
FIG. 29. Section, nearly longitudinal, posterior extremity of female, borax carmine stain, magnified about 210 diameters; *a*, cuticle; *b*, granulo-fibrous layers of subcuticula; *c*, vascular layer of subcuticula with radial fibers; *d*, circular muscle layer; *e*, longitudinal muscle layer; *f*, uterus; *g*, inner, and *h*, outer sphincter muscle of uterus; *i*, nucleus of longitudinal muscle layer; *k*, nucleus of outer sphincter muscle of uterus; *l*, lumen of vessel in vascular layer; *m*, ovarian mass in body cavity.
FIG. 30. Ovarian mass from body cavity, × about 900 diameters.
Sketches by the author.

PLATE IV.

Echinorhynchus pristis, Rudolphi.

FIG. 31. Proboscis and anterior part of body of female from *Tylosurus caribbæus;* sketch from living specimen, × about 27 diameters.
FIG. 32. Base of proboscis of same, × about 200 diameters.
FIG. 33. Median region of proboscis of same, × about 200.
FIG. 34. Hooks from ventral side of proboscis, anterior end.
FIG. 35. Dorsal hook near base of proboscis.
FIG. 36. Ventral hooks near base of proboscis.
FIG. 37. Hooks from basal circle.
Figs. 34 to 37 have the same magnifications, viz, about 200.
FIG. 38. Spine from anterior part of body, × about 225 diameters.

Var. *tenuicornis*.

FIG. 39. Hooks from proboscis of male from *Tylosurus caribbæus*, × about 200.
FIG. 40. Hooks from proboscis of female from *Lobotes surinamensis*, × about 200.
FIG. 41. Portion of proboscis of male from *L. surinamensis*, × about 200.
Fig. 31 from sketch by M. B. Linton, others by author.

PLATE V.

Echinorhynchus pristis, Rudolphi.

Var. *tenuispinis*.

FIG. 42. Portion of proboscis of female from *L. surinamensis*, × about 200.
FIG. 43. Hooks from proboscis of male from *L. surinamensis*, × 200.
FIG. 44. Hooks, same as Fig. 42, isolated, × about 200.
FIG. 45. From same as Fig. 43, × about 200.
FIG. 46. Spines from anterior part of body of female from *L. surinamensis*, × about 200.
FIG. 47. Same as Fig. 46, but nearer anterior end.
FIG. 48. Spine from anterior part of body of male from *L. surinamensis* (see Fig. 50), × 200.
FIG. 49. Spine immediately behind neck (see Fig. 50), × 200.
FIG. 50. Male from *T. caribbœus*, × about 27 diameters. (Sketch from life.)
FIG. 51. Hook from proboscis of same, lateral view, × about 225.
FIG. 52. Front view of hook, same, × about 200.
FIG. 53. Portion of proboscis of male from *T. caribbœus*, × 200.
Fig. 50 from sketch by M. B. Linton, others by author.

PLATE VI.

Echinorhynchus incrassatus, Molin, young.

FIG. 54. Young male from peritoneum of *Lophius piscatorius*, sketches from living specimen compressed, × 15.
FIGS. 55 to 58. Epidermal spines anterior part of body of same, × about 200. Figs. 55 and 58, front view; Fig. 57, side view of same; Fig. 56, two lateral views of same spine, seen in planes at right angles to each other.
FIG. 59. Caudal spines of same, × 225.
FIG. 60. Hooks near base of proboscis of same, × 200.
FIG. 61. Hooks near apex of proboscis, front view of same, × 200.
FIG. 62. Hooks near middle of proboscis of same, lateral view, × 200.
FIG. 63. Hooks near apex, lateral view, × 200.
FIG. 64. Nucleated cells ranging from 0.02 to 0.06^{mm} in diameter. These lay in clusters near the proboscis sheath, shown by the oval, shaded patch lying behind the proboscis sheath in Fig. 54.
FIG. 65. Young specimen from peritoneum of *Paralichthys dentatus*, sketch from alcoholic specimen, × about 27 diameters.
FIG. 66. Epidermal spines, anterior part of body of specimen from peritoneum of *Pomatomus saltatrix*, × about 200.
FIGS. 67 to 69*a*. Hooks from proboscis of same, same enlargement, viz, about 200 diameters; 67, median; 68, near apex; 69 and 69*a*, basal.
Sketches by the author.

PLATE VII.

Echinorhynchus agilis, Rudolphi.

FIG. 70. Optical section of male, from *Roccus americanus*, × about 27 diameter
FIGS. 71–72. Fig. 71, large hook from proboscis; Fig. 72, embryo of same;

Echinorhynchus serrani.

FIG. 73. Specimen from peritoneum of *Serranus atrarius*, × 6.
FIG. 74. Anterior of same, × about 16; *a*, epidermis of anterior end remov turned to one side; *b*, epidermis still in place; *c*, proboscis ret within its sheath; *d*, lemniscus; *e*, sheath of proboscis.
FIG. 75. Portion of epidermis, × 200.
FIGS. 76–79. Hooks from proboscis, same enlargement, viz, about 200; 76, bas median and antero-median; 78, apical; 79, basal.

Echinorhynchus sagittifer, Linton.

FIG. 80. Longitudinal section of body at base of proboscis sheath, × abou Specimen from peritoneum of *Paralichthys dentatus*. Sections mad specimen killed with Perenyi's fluid and stained with Grenacher's carmine; *a*, outer, *b*, inner muscular layer of the proboscis she nucleus of intra-fascicular substance of retractor muscle of pro *d, d*, cuticle; *e, e*, outer layers of subcuticula; *f, f*, inner layer of ticula, with radial fibers but no vascular spaces; *g, g*, circular layer; *h, h*, longitudinal muscle layer; *i, i*, homogeneous sub occupying the body cavity; *k*, one of the ventral spines; *l, l*, o masses.

Echinorhynchus odontaspidis.

FIG. 81. Anterior end of specimen from *Carcharias littoralis*, × 12; *a, a*, lemni invaginated portion of body; *c*, proboscis retracted within its s *d*, retractor muscle of proboscis.
FIG. 82. Hooks from proboscis, × about 200.
Sketches by the author.

PLATE VIII.

Echinorhynchus carchariæ.

FIG. 83. Posterior end of individual figured on previous plate, optical section, ing uterus crowded with embryos, somewhat diagrammatic, × 24.
FIG. 84. *a*, Ovarian mass from body cavity; *b, b*, embryos; × about 200 diam

Echinorhynchus proteus, Westrumb.

FIG. 85. Proboscis of specimen from *Roccus lineatus*, × about 100 diameters.
FIG. 86. *a, b*, Hooks from tumid part of proboscis; *c*, from near base, × abo diameters.
FIG. 87. Posterior end of male, treated with potassic hydrate to make transp *a, a*, testes; *b*, prostatic glands; *c*, ejaculatory duct; *d*, bursa.
FIG. 88. Male with abnormal head; *a*, granular substance filling the oval There was no trace of proboscis or bulla in these degenerate indiv unless the oval body represents the latter; *b*, everted bursa.

Echinorhynchus acus, Rudolphi.

[Continued from Plate I.]

FIG. 89. *a*, Cuticle; *b, c, d*, outer layers of subcuticula; *e*, vascular layer c cuticula; *f*, layer of circular muscles; *g*, longitudinal muscle *h*, ovarian mass; *i, i*, cut branches of vessels; × about 200 diame
FIG. 90. Nerve ganglion isolated, × about 250 diameters.
Sketches by the author.

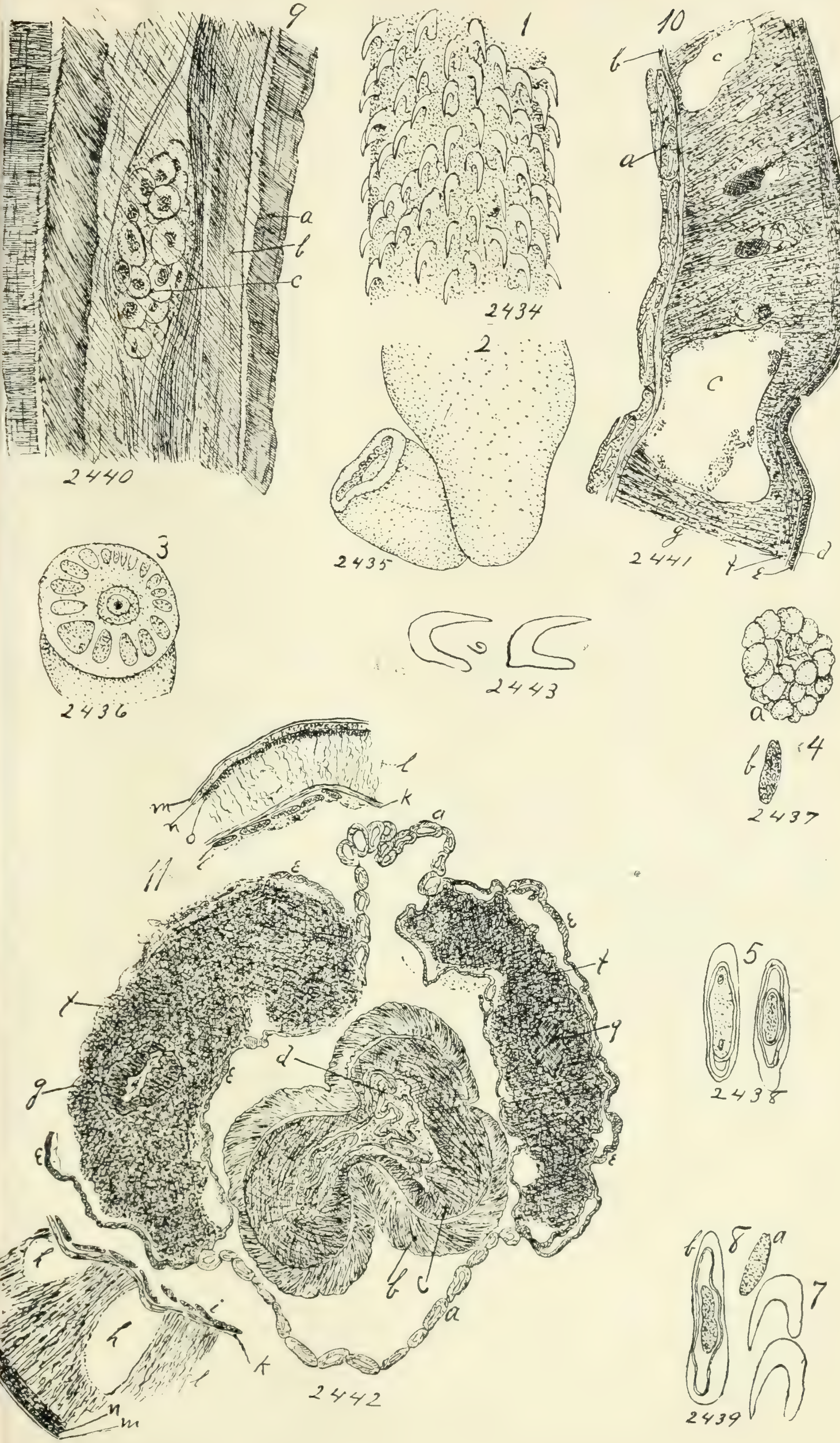
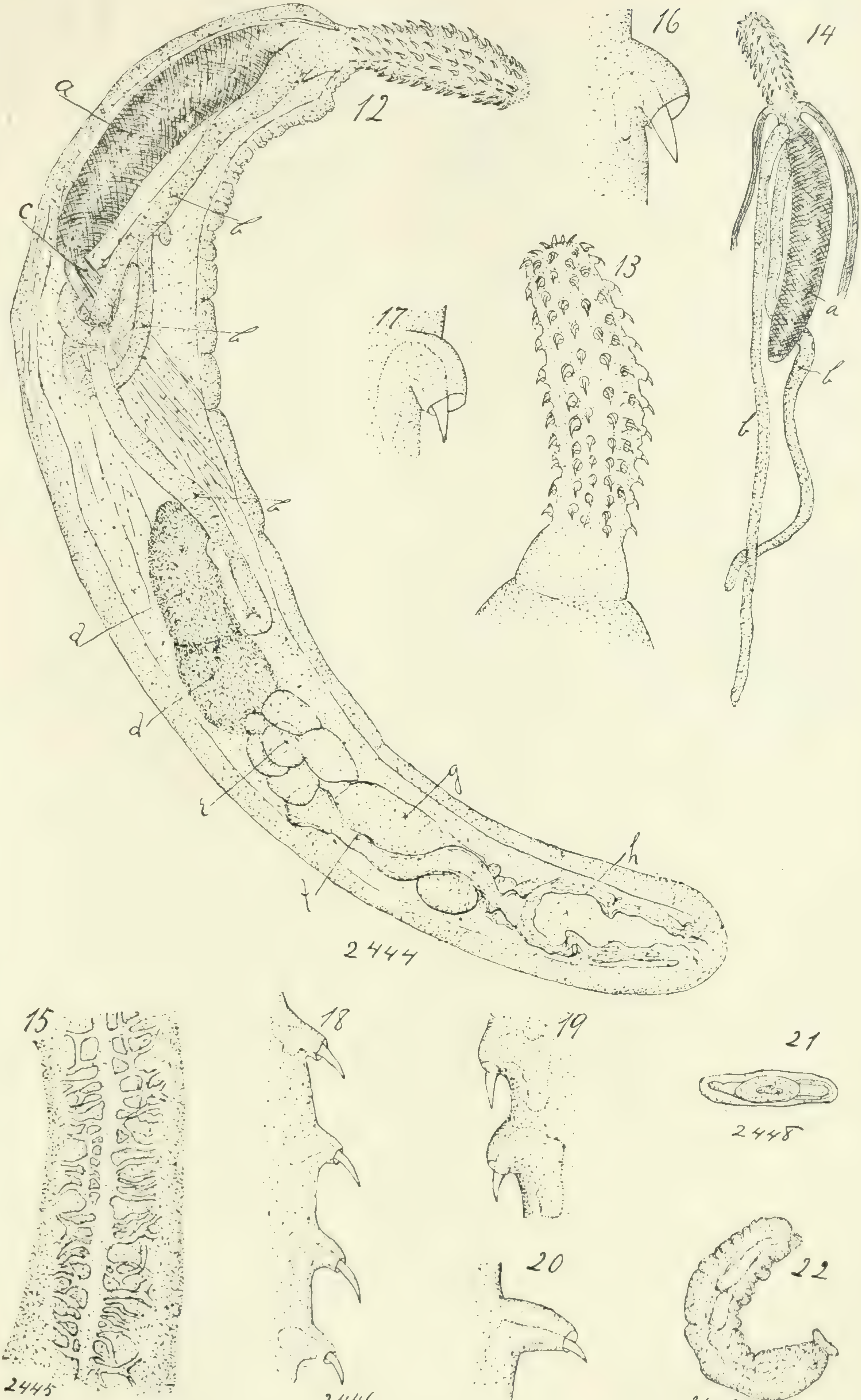
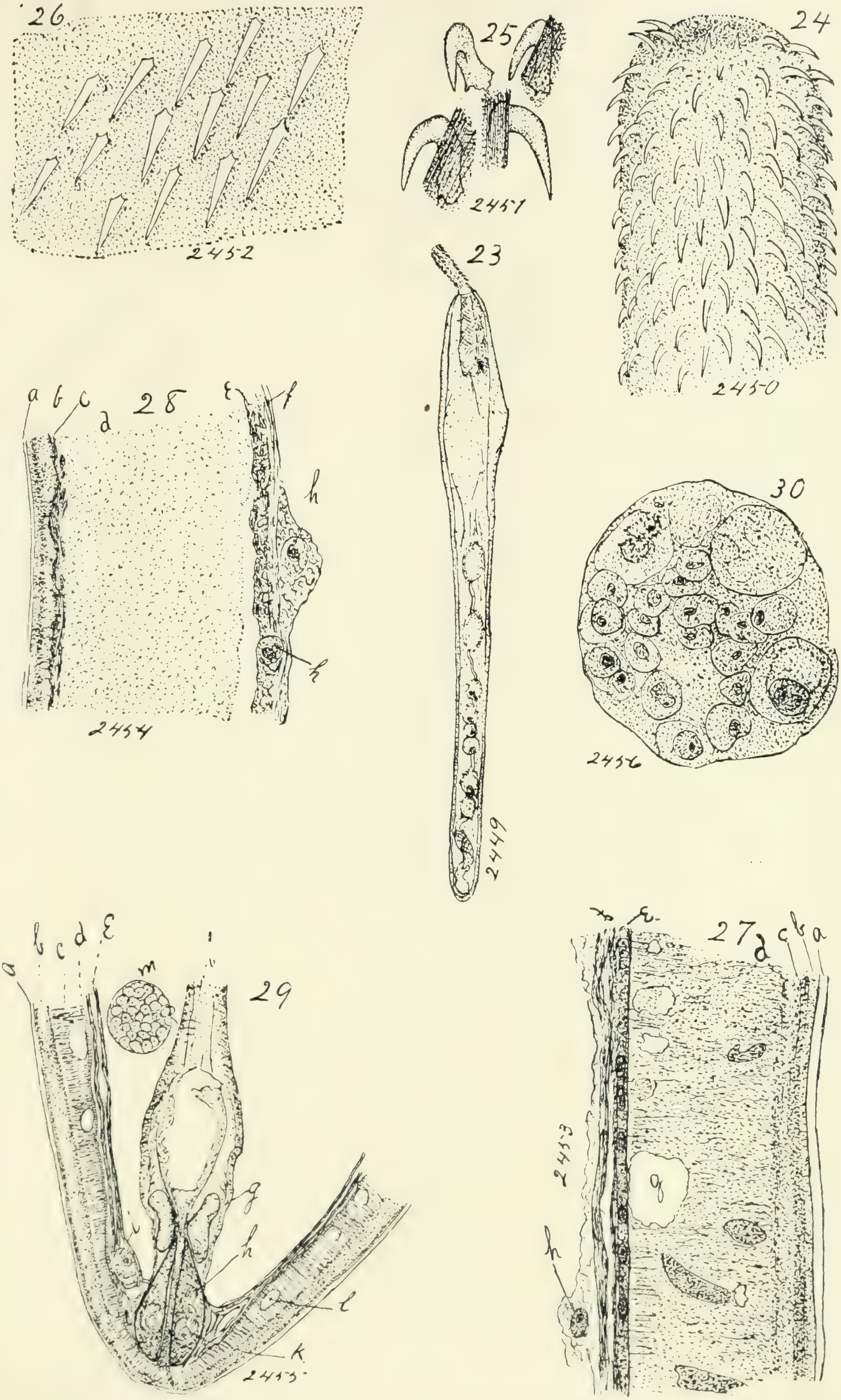
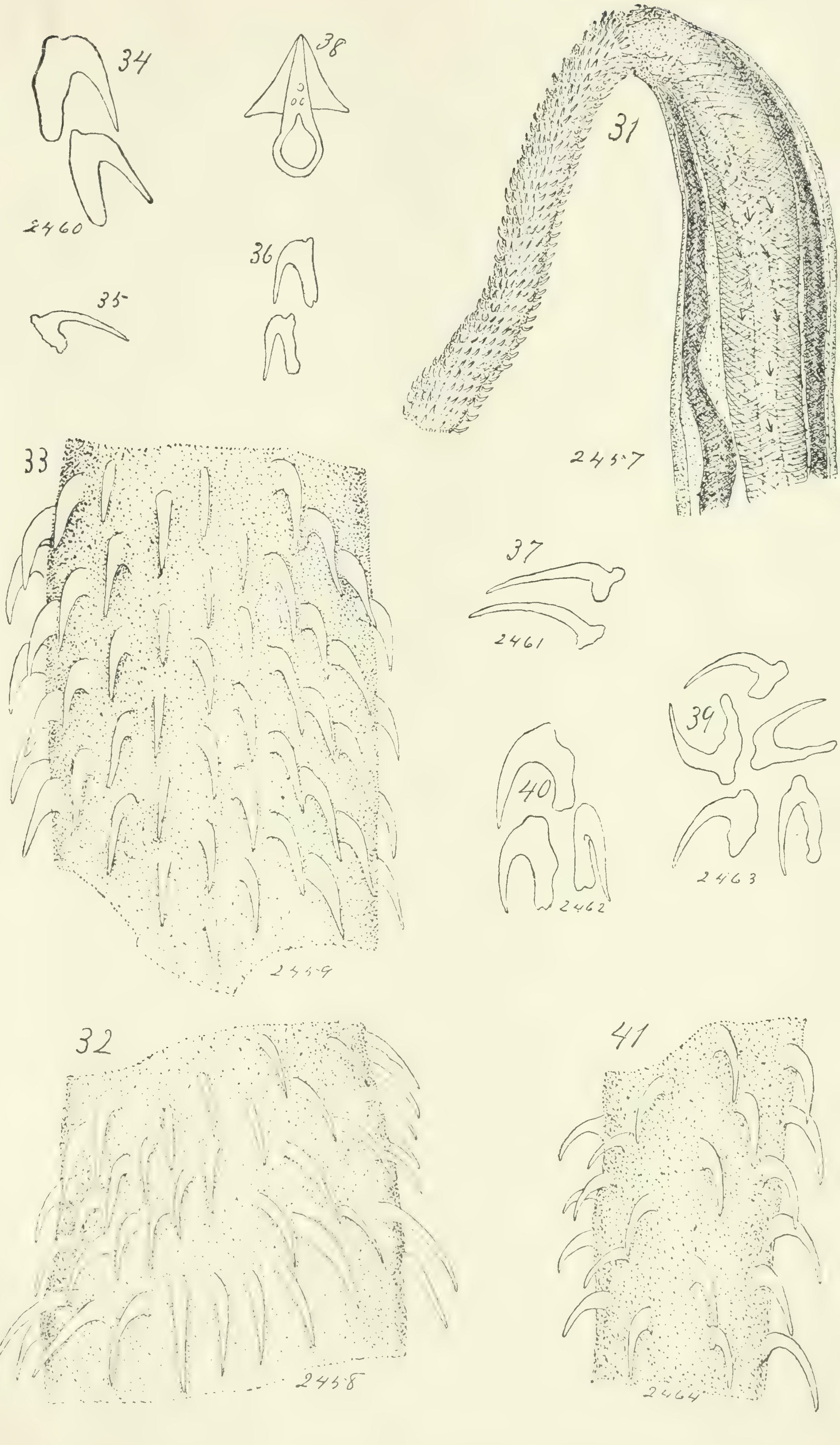
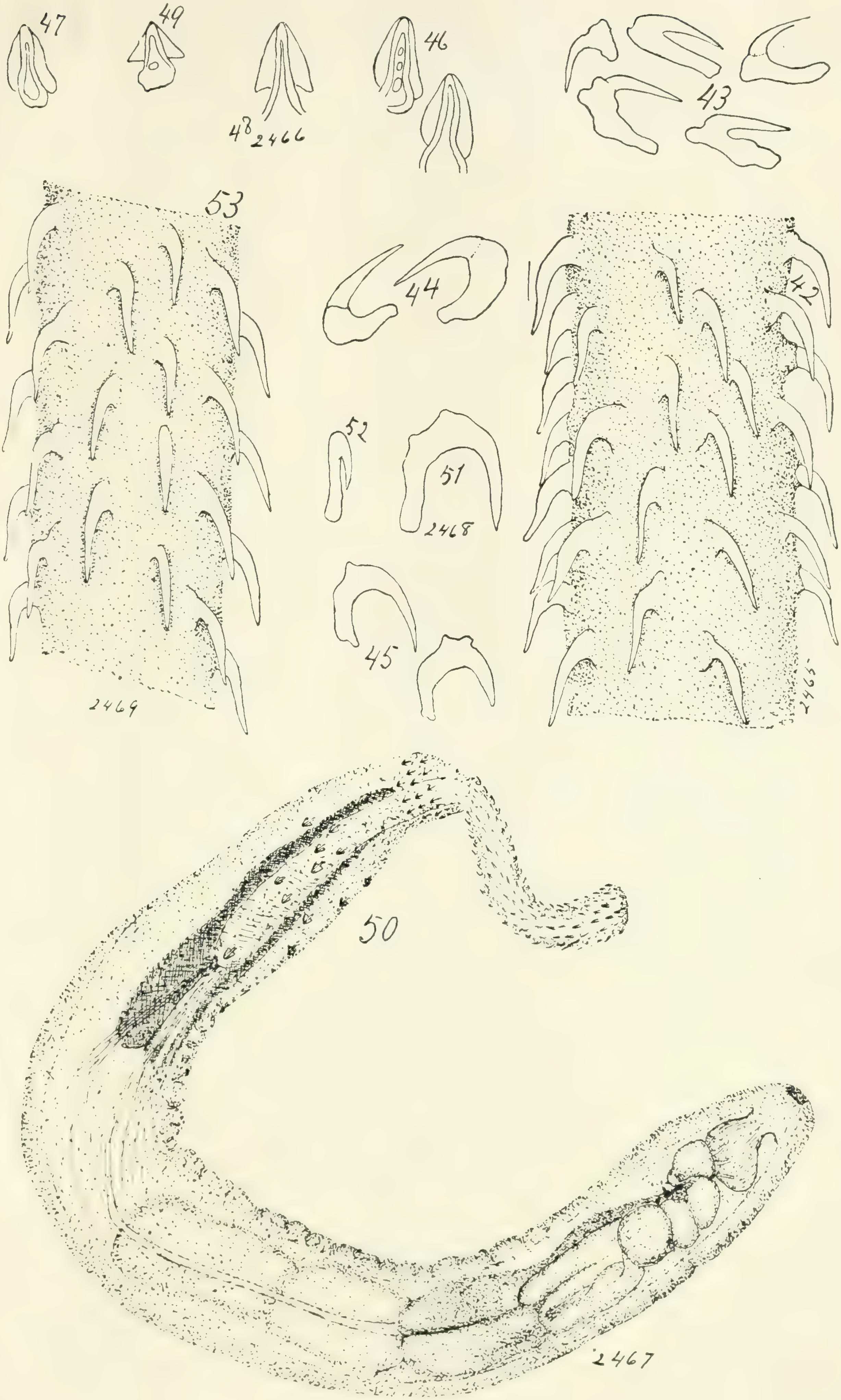

9
2440
1
2434
2
2435
10
2441
3
2436
2443
4
2437
11
2442
5
2438
8
7
2439

PLATE LIV.


12
a
b
c
d
e
f
g
h
i
2444
16
14
a
b
13
17
15
2445
18
2446
19
20
21
2448
22
2447

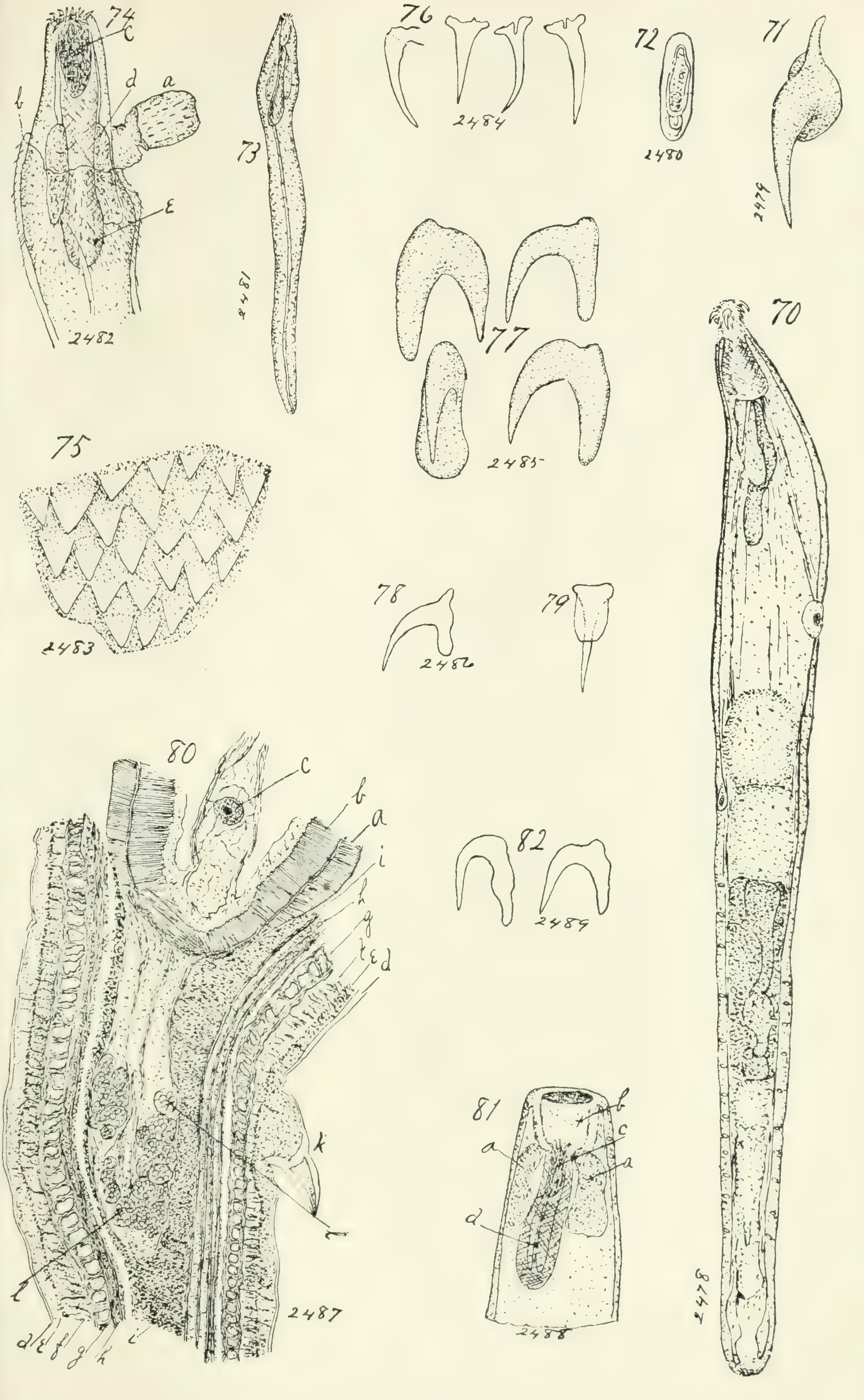

26
2452
25
2451
24
2450
23
2449
28
2454
30
2456
29
2455
27
2453


34
2460
38
36
35
31
2457
33
37
2461
39
40
2462
2463
2459
32
2458
41
2464


47
49
48
2466
46
43
53
44
42
52
51
2468
45
2469
2465
50
2467

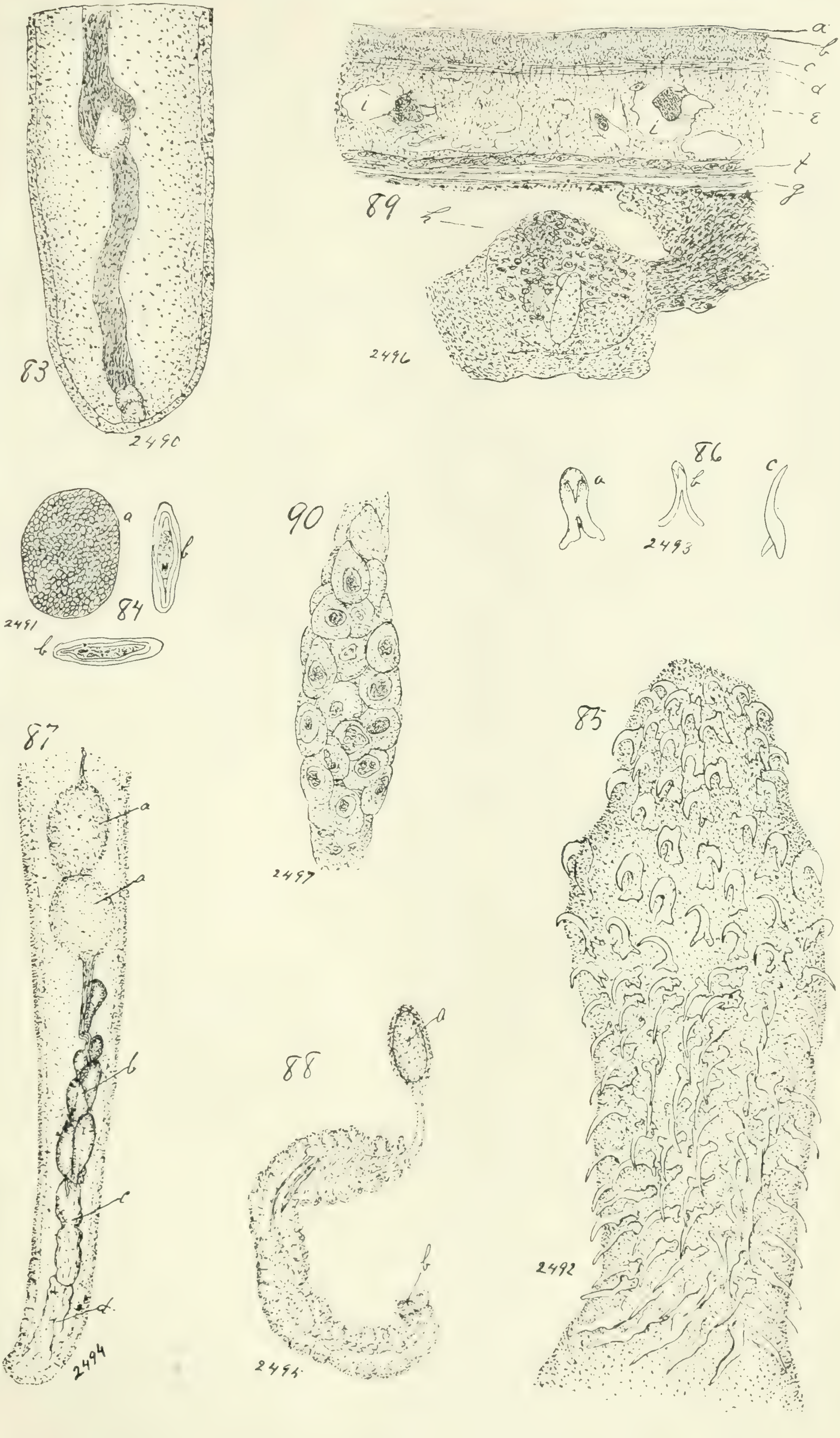

60
2472
61
62
2473
64
2474
63
69a
2477
55
56
57
58
59
2471
68
2474
67
247
65
69
2476
66
54
2470

PLATE LIX.



74
2482
73
2481
76
2484
72
2480
71
2479
77
2485
70
2478
75
2483
78
2486
79
80
2487
82
2489
81
2488

PLATE LX.



7.—ON THE ANATOMY OF THYSANOCEPHALUM CRISPUM, LINTON, A PARASITE OF THE TIGER SHARK.

By EDWIN LINTON, PH. D.,
Professor of Zoölogy in Washington and Jefferson College.

I.—HISTORICAL.

The first notice of this species was published in the author's "Notes on the Entozoa of Marine Fishes of New England," U. S. Fish Commission Report for 1886, pages 464–468, plate II, figs. 1 to 12. It was there described under the name *Phyllobothrium thysanocephalum* sp. nov. Subsequently it was discovered that it had been referred to the genus *Phyllobothrium* improperly. A new generic name was needed to accommodate it, and the species was therefore renamed as above in the author's "Notes on Entozoa, Part II," U. S. Fish Commission Report for 1887, pages 823, 824. Notice of the change of name was given in a brief abstract of the latter paper in the American Journal of Science for March, 1889, page 240. The position to which the genus is assigned in the second paper is in the family *Tetrabothriidæ*, subfamily *Philacanthinæ*.

II.—HABITAT AND DISTRIBUTION.

This parasite has been found by the author thus far only in the tiger shark (*Galeocerdo maculatus*), and there only on three occasions, viz, July 23, 1885, August 3, and August 14, 1889, all at Wood's Holl, Massachusetts. In each case young, half-grown, and adult specimens were found together in the spiral valve, showing that the source of infection is distributed throughout a considerable portion of the year. In each instance, also, the parasites were numerous, and, in addition to the strobiles, the chyle was teeming with free proglottides, which were contracting and elongating in the most active fashion, and achieving a kind of progressive motion by means of a sucker-like use of the hilum at the anterior end.

The host, according to Jordan and Gilbert, has a range from Cape Cod to the Indian Ocean. It would be too much, of course, to infer that the parasite is coextensive in geographical distribution with its host. This depends upon the range of individuals of the final host, and of the distribution of the intermediate host or hosts, rather than on the distribution of the species to which the host belongs. No mention

is made of entozoa from this host either in the compilations of Diesing and Von Linstow or in the memoirs of Van Beneden, Molin, Oerley, Zschokke, etc., who have investigated the entozoa of the Selachians.

In the first two finds this parasite was the sole occupant of the spiral valve. In the last there were associated with it in the same organ several small cestods apparently identical with *Orygmatobothrium angustum* Lt. There were also a few scolices of a *Tetrarhynchus* attached to the walls of the stomach. A few large nematods were found in the stomach of each host. In the first and third finds there were a few long, slender, free proglottides not belonging to this species. These have not yet been satisfactorily accounted for. In the third lot they may belong to the Tetrarhynchi found in the stomach.

The character of the stomach contents throws but little light on the nature of the intermediate host. The stomach of the first was probably empty, at least there is no record of any stomach contents in the notes made at the time of collecting. In the second case, a half-grown female, the stomach was filled with half-digested menhaden (*Brevoortia tyrannus*). The third host, which measured about 7 feet in length, had in its stomach a bonito (*Sarda sarda*), the operculum of a large fulgur, and a large quantity of sandy mud. There were several hundred *Thysanocephala* in the spiral valve of this shark.

III.—DESCRIPTION OF THE SPECIES; EMENDATIONS.

The original description, while, in the light of more recent and careful investigations, faulty in some particulars, is sufficiently accurate to make identification of the species reasonably satisfactory. A revised description is given in the U. S. Fish Commission Report for 1887. A brief, systematic description of the species is, therefore, all that is necessary in this paper.

Scolex very small, about the same size in large as in small individuals, thus appearing minute when compared with the large cervical ruff or pseudoscolex of an adult; quadrangular in outline and provided with four oblong bothria, each armed with two short, straightish hooks, and with a single anterior loculus in front of the hooks. Each bothrium is thus divided into two pits or loculi by a transverse partition, which also bears the hooks at its extremities. During life the bothria are very versatile, moving backward and forward singly or in either parallel or diagonally opposite pairs. The anterior loculus is somewhat circular in living specimens, semicircular or crescentic in alcoholic specimens (figs. 4 and 6). The posterior pit is oblong-elliptical in living, somewhat shorter and broader in alcoholic specimens. The borders of the bothrial loculi are thin, but supported at the edges by a band of dense epithelial tissue. The neck immediately behind the scolex is slender, short, and cylindrical, usually in living and always in alcoholic specimens contracted and concealed within the voluminous cervical folds.

The latter constitute an abrupt expansion into a large, lobed, crisped, and folded mass, which, in alcoholic specimens, is more or less globose or disciform, but in living specimens may be spread out into a flat suctorial disk with fimbriated edges. This organ is so conspicuous and takes the place of bothria so effectually as an organ of adhesion that it may be called with some degree of propriety the pseudoscolex. The diameter of this organ may be from five times, in small specimens, to thirty or more times in adult specimens the diameter of the scolex.

Behind the pseudoscolex the body is broad, somewhat flattened, traversed by deep longitudinal rugæ, covered by fine transverse striæ. The unjointed part of the body is long and nearly linear. The segments begin remote from the head, at first as transverse wrinkles; subsequently they decrease slightly in breadth and increase gradually in length. Near the posterior end they are squarish and at the extreme posterior end two or three times as long as broad. The free proglottides, are oblong, truncate posteriorly, anterior angles rounded, and usually appressed and surmounted by a rounded tip at the anterior end, often breaking away before ova are developed, ultimately becoming much elongated.

Genital aperture a marginal cloaca. Cirrus long with spinose base. Length of strobile as much as 1 metre.

Varieties.—There are two types of the adult specimens based on the character of the pseudoscolex. In one there are several, six or eight, primary folds radiating from the scolex, each primary fold being made up of a number of smaller secondary folds. This type is rather poorly represented by the specimen sketched in fig. 1, which is from a small specimen where the distinction is not so strong in this particular as in the adult. A better example is figured in the author's Notes on Entozoa, U. S. F. C. Report, 1886, plate II, fig. 1.

The second type has a much more compact pseudoscolex, and the radiating folds are illy defined, fig. 7. These types are probably due to different degrees of contraction of the strong longitudinal muscles, many of which enter the pseudoscolex direct from the body without passing through the neck proper.

Emendation of original description.—The specimens which were obtained in the first find did not exhibit any movements of the scolex. The scolex was observed only in the smaller specimens, where it appeared to be a rigid body of chitinous structure and in some instances became detached during the examination of the fresh specimens. The scolex was not observed in the larger specimens, though doubtless present in all, the neck being contracted and the scolex buried among the small folds of the apex of the pseudoscolex. Furthermore the specimens were among the first of this difficult group which the author attempted to identify. Hence an inexcusable, though not unnatural, mistake was made in regarding the scolex as a hooked rostellum, characteristic of young specimens, but an evanescent character lost in the

adult, and therefore not to be given undue weight in a systematic description.

The resemblance between the pseudoscolex of these specimens and the scolex of *Phyllobothrium lactuca* was quite striking and naturally suggested a generic relation. This was borne out also by a decided resemblance between the mature proglottides of the two forms.

When, in the summer of 1889, the opportunity of studying a fresh lot of these parasites was afforded the author, the discovery was speedily made that the organ at first thought to be a rostellum is in reality a true scolex with hooks. The relationship of the species to genera of the *Tetrabothriidæ* with armed bothria, such as *Calliobothrium*, *Acanthobothrium* and the like, was thus established.

IV.—ANATOMY.

Method of study.—No special preparation was made of the first lot other than to kill in weak alcohol and pass the specimens through different grades of the same of increasing strength. In the other lots more care was taken in preparing the material for study. Specimens were hardened in Perenyi's fluid, picro-sulphuric acid, osmic acid, and hot corrosive sublimate. The most satisfactory series of sections were obtained from the picro-sulphuric preparations of some small individuals stained *in toto* in a dilute solution of Beale's ammonia carmine in glycerine. The specimens were allowed to remain in the staining fluid for several days. Preparations almost equally good were obtained from Perenyi's fluid, followed by borax carmine (Grenacher's). Corrosive sublimate and Perenyi preparations stained with hæmatoxylon (Bömer's) were also quite satisfactory. The stained specimens were imbedded in paraffin, serial sections cut with the Ryder microtome, the sections fastened with Schällibaum's fixative (clove oil and collodion), and mounted permanently in Canada balsam.

In order to make out the structure of proglottides with least perplexity it is necessary to have sections made in three directions—transverse, longitudinal parallel with a lateral face, and longitudinal at right angles to a lateral face.

The structure can be understood better from the sketches than from a written description.

The following remarks are based on the same series of sections from which selections were made for the illustrations, and will probably make the latter more intelligible.

Cuticle.—In the scolex the framework is made up of closely packed, short, parallel fibers which appear to be epithelial cells. This tissue is very resistant, withstanding the action of cold, and yielding very slowly to the action of hot, caustic potash.

In transverse sections and in longitudinal sections made perpendicular to the face of a bothrium, the fibers are seen in their long dimensions

lying parallel with each other. In longitudinal sections made parallel with the face of a bothrium, some of them are seen in cross section.

The cuticle of the body is a very remarkable structure. In superficial view, especially in a stained specimen, it appears to be scaly or, more properly speaking, minutely and irregularly tessellated, since the pieces do not break joint (figs. 24*c* and 33*a*).

In section the cuticle is seen, when highly magnified, to be made up of three distinct layers. These may be described as an outer epidermal layer, an inner epidermal layer, and a third limiting layer, the cutis (figs. 21*a*, 27, and 31).

The outer epidermal layer under high magnifying power shows a densely striated structure, the striæ being at right angles to the superficial extent of the layer. The inner epidermal layer appears very finely granular and usually almost homogeneous. In some especially good sections, however, fine striæ were seen in it. These also lie at right angles to the layer, but are not close together as in the external layer, and the interstices are filled with fine granular material. The epidermis rises in folds from a very thin limiting membrane, the cutis, to which the fine radial fibers of the subcuticular granulo-fibrous layer are attached (fig. 21*a*).

The outer epidermal layer is uniform in thickness; the inner layer is irregular in thickness, rising from a comparatively uniform base, where it touches the cutis, into papillæ which conform to the folded structure of the outer layer.

A few small granular patches, of glandular appearance but of unknown significance, were observed in this layer (fig. 31*a*).

The epithelial origin of the hooks of the scolex is shown in fig. 13. In unstained specimens treated with caustic potash the hooks appear transparent and homogeneous.

The hooks in this species differ from the chitinous hooks of such genera as *Calliobothrium* in that they are solid and not characterized by having an internal cavity. The epidermal layers of the body do not extend, at least unmodified, into the pseudoscolex.

The external folds of the pseudoscolex appear in section as fimbriæ, about 0.02^{mm} in diameter. The folds are seen to be limited on each side by a thin, uniform layer, apparently structureless and about 0.002^{mm} thick. This layer appears to be continuous with the cutis of the body. In the deeper parts of the folds, that is, toward the center of the pseudoscolex, this cuticular layer becomes somewhat thickened and is irregular or broken on the surface. In some cases it was seen to bear on its outer surface what appeared to be a dense coat of epithelial hairs.

This cuticular layer is in close connection with the longitudinal muscles of the body, which extend, mostly as radial fibers, into the pseudoscolex. It is itself apparently contractile. Indeed, it and the cutis of the body may subsequently be shown to belong to the subcuticular layer.

Internally the external folds of the pseudoscolex are composed of

granular tissue. In both transverse and longitudinal sections of the pseudoscolex this granular material is seen, along with a faint indication of an incipient striated arrangement of the granular material.

Musculature.—The muscular system is not complicated. Viewed in transverse section near the anterior end, the body is seen to be made up of three principal layers, each of which is more or less muscular. These are disposed between a central core and the cuticle in the following manner: The inner layer immediately surrounding the central core is composed of circular muscle fibers. The fibers are rather strong, but the layer is not thick. The circular layer is surrounded by a layer of strong longitudinal fibers. In the anterior regions of the body this layer is very prominent and the fibers are large and strong. Outside of this layer is the subcuticular layer, which contains both longitudinal and radiating fibers along with an abundance of granular material. The fibers in this layer are very slender. The layer itself is a prominent one, and in the posterior parts of the body is proportionally thicker than the other layers.

Longitudinal muscles.—These are the most prominent muscles of the anterior part of the body (fig. 20). In a specimen measuring over 30 centimetres in length the longitudinal fibers were found to be collected into a comparatively small area at a distance of 6 centimetres from the head, presenting, in fact, much the same aspect as shown in fig. 35. The disposition of this layer in the posterior regions of the body is made sufficiently clear in figs. 26, 27, 29, 30, 31, and 35. By a reference to figs. 10, 11, 17, 18 to 22, 24, and 25, it will be seen that the longitudinal muscles play a very important part in the structure of the head, and particularly of the pseudoscolex. Longitudinal fibers extend up through the slender neck and communicate with the bothria. Dense fascicles of these fibers enter the cervical folds in outgrowths which form the pseudoscolex, where many of them appear as radiating or transverse fibers. The longitudinal fibers which supply the bothria lie in the superficial area of the neck (figs. 11, 17, 18, and 22). A short distance back of the scolex four processes or outgrowths are given off from the neck. Each process contains an abundance of strong muscles which appear to radiate from the neck. Some of them are fibers which are radial or transverse throughout, and may be traced from one process or fold to another. Others are continuous with the longitudinal muscles of the body, which are here deflected nearly at a right angle from an axial direction. In the angles between the cervical processes longitudinal fibers may be seen in transverse sections, and may be traced from the longitudinal system of muscles in the body to the base of the bothria, where they communicate with those organs by a kind of frenum. In succeeding sections back from the head the cervical outgrowths are seen to increase rapidly in size and to become variously divided.

Interlacing muscular fibers running from one process to each adja-

cent one make up the principal mass of the neck as it passes through the pseudoscolex, of which organ it is the axial center (figs. 17, 18, and 22). The outer extremities of the massive parts of the cervical outgrowths receive muscular fibers from the longitudinal body layer. These extend to the base of the fine outer folds, where they seem to blend with the cuticular limiting layer, in which the contractile power, which the outer folds undoubtedly possess, apparently in large measure, resides (figs. 17*a*, also figs. 19 and 24).

Near the base of the pseudoscolex the neck enlarges very rapidly (figs. 19, 20, and 24). The last cervical outgrowths to disappear are the two lateral ones. In fig. 20, *d*, *d* indicate the position of the last cervical process to disappear. The longitudinal muscle layer is here seen to approach the cuticular layer. In the section immediately preceding this a few longitudinal fibers extend outward as radial fibers from these points. Figs. 19 and 24 give views of longitudinal sections of the head and pseudoscolex, but do not give a correct idea of the cervical processes in their entirety. The sections are made parallel to the lateral face of the body and pass through intervals between the cervical outgrowths. From the diagrammatic sketch, fig. 25, a somewhat better idea may be obtained. Figs. 17 and 22, which are from camera-lucida drawings of transverse sections, give a correct representation of these peculiar organs.

The very powerful longitudinal muscles of the anterior part of the body and their continuation into the cervical processes and folds, where they are further supplemented by another powerful set of interlacing transverse muscles, all indicate this to be a most efficient suctorial organ. This view is further substantiated by the fact that the structure of the external folds of the pseudoscolex is such that they may act as so many sucking disks.

Here then is a very curious instance of the development of a special organ for a special purpose, instead of the modification of an organ already possessed; or rather the development of an unusual part to perform a function which is normally performed by an organ which the animal already possesses. In kindred Cestods the organs of attachment are the bothria or cupping disks which are homologues of the sucking disks of the common Tænia. These may be supplemented by various contrivances in the shape of secondary disks as in *Orygmatobothrium*, by partitions dividing the bothria into loculi as in *Echeneibothrium*, by hooks as in *Calliobothrium*, by hooks and spines as in *Echinobothrium*, etc.

The pseudoscolex of *Thysanocephalum* is probably a no more remarkable organ than the proboscis of *Tetrarhynchus*, but it appears to be unique in having become such a conspicuous and manifestly essential organ, while the true scolex and slender neck would be wholly inadequate of themselves to sustain the strain of supporting the adult body.

That the head, though so minute, still retains the supremacy, however, is shown by the fact that the nervous system has its chief devel-

opment there. How long a strobile would continue to live in its proper habitat if the scolex were removed is an interesting though not very practical question.

While the pseudoscolex appears to be principally an organ for adhesion and absorption, as well designed for the former function perhaps as for the latter, the true scolex, though no doubt necessary as an organ of adhesion in very young individuals, must be of little use for this purpose in the adult.

In the mature segments the longitudinal system of muscles is reduced to a narrow and inconspicuous layer.

Circular muscles.—The layer of circular fibers is at first clearly defined at the base of the pseudoscolex. Anterior to that point they either do not exist or are obscured by the numerous interlacing fibers of the cervical outgrowths. It constitutes a conspicuous layer in the anterior part of the body. In the median regions of the body it consists of but a few fibers, and in those segments in which the genital organs are mature it has almost entirely disappeared, being there represented by a few fine fibers which, with the attenuated layer of longitudinal fibers, surround the inner core of the strobile.

Subcuticular granulo-fibrous layer.—This layer is first discernible at the base of the pseudoscolex. Anterior to that point the longitudinal layer lies next to the cuticular layer. It becomes one of the most prominent of the layers of the body a short distance back of the pseudoscolex. It consists of both longitudinal and radial fibers, and at its extreme outer edge there is a layer which appears to consist of fine circular fibers placed very close together, appearing as a thin structureless membrane in transverse sections, but presenting the appearance of a row of fine dots in longitudinal, marginal sections. It furnishes a place of insertion for the radial fibers and has been interpreted as the cutis, and so named in the figures and in the description of the cuticle. The subcuticular layer in the median region of the body occupies more than one-half the area from surface to center of transverse sections. Its prominence in the mature segments is shown in figures 26, 27, 29, 30, 31. It furnishes the material from which the vitelline glands develop.

Inner core of the strobile.—In the anterior region of the body this contains, beside the longitudinal and nerve vessels, more or less granular or nuclear material in the loose and open meshes, formed by fibers which cross from side to side and others approximately at right angles to them. In the neck this space is quadrangular and poorly defined. Immediately behind the pseudoscolex it is elongated and lenticular in transverse sections. This general character is preserved throughout until distorted by the genitalia, which develop within and from its substance.

Water vascular system.—Four longitudinal aquiferous vessels traverse the anterior part of the body. They are situated in pairs towards the margin of the central core. Each marginal pair consists of a large

and a small vessel, the latter nearer the margin. The course of the larger one is very tortuous, so that in moderately thin transverse sections it often appears as a double vessel (figs. 20, 21). The tortuous course of one of the large vessels is shown in fig. 23. The course of the smaller vessels is sinuous. Branches of the water-vascular system extend to the apex of the scolex (fig. 14). Lateral branches enter and ramify through the primary folds of the pseudoscolex (fig. 17*l*′). Towards the base of the scolex the neck is traversed by four vessels (fig. 10). A little further back, at the beginning of the cervical outgrowths, they are poorly defined (fig. 11). The interior of the neck at this point is made up of spongy tissue composed of interlacing fibers, and lateral vessels may be seen entering the cervical outgrowth. Fig. 11, *l*′, shows the first indication of one such lateral branch, which becomes quite evident a few sections farther on in the series. Towards the base of the pseudoscolex the lateral branches again unite with the central longitudinal vessels of the neck (figs. 17 and 22). At the point where the neck begins to broaden abruptly the aquiferous vessels are larger and appear to form a kind of plexus of vessels (fig. 19, *l*′). The exact disposition of the aquiferous vessels in the neck, pseudoscolex, and scolex have not been made out satisfactorily. Fig. 25 is a diagrammatic representation of what appears to be their general disposition. Near the anterior end of the body the smaller of the marginal vessels are from one-third to two-thirds the diameter of the larger vessels. As the vessels proceed towards the posterior end the large vessels increase in size very much, while the small vessels are relatively much smaller than they are near the head.

In sections made about the middle of a large specimen, a large aquiferous vessel measured 0.135^{mm} by 0.162^{mm} in its two diameters; the smaller vessel of the same pair measured only 0.022^{mm} by 0.030^{mm} in its two diameters. Nearer the posterior end a large vessel measured 0.162^{mm} in diameter; its small companion only 0.016^{mm}, or but one-tenth as much. In segments in which the sexual organs are mature only the large vessels persist, and they, too, are merged in the general body cavity in ripe segments. The aquiferous vessels are surrounded by a proper wall which is quite thin, with a few nuclei surrounding it.

Nervous system.—A cluster of nucleated cells, the largest of which measured 0.06^{mm} in diameter, in a finely granular mass and lying centrally in the scolex about on a level with the anterior loculi, has been interpreted as the anterior development of the nervous system (figs. 8, 14, and 15). This mass is traversed by exceedingly fine transverse and by coarser longitudinal fibers. Toward the base of the scolex the nerve tissue is collected into two marginal areas, in which there are a few nucleated cells on the peripheral side of the aquiferous vessels (fig. 10). In the neck their course can be traced as two cords or vessels of spongy, granular tissue, when seen in cross-section, or of finely striated spongy and granular tissue when seen in longitudinal section

(figs. 11, 17 to 22). Under high magnifying power occasional nucleated cells are visible. The nerve vessels extend back through the body, one near each margin of the central core (figs. 19, 20, 32). They were observed in sections made near the middle of the strobile, where the genitalia had already begun to develop. No nucleated cells were observed in the posterior extension of the nerve vessels, where they appear to consist of spongy tissue alone. These vessels are without proper walls in any part of their course.

Genitalia.—Along one of the lateral faces of each mature segment there is a depression, which is called in the explanation of the figures the lateral furrow (figs. 26, 27, 29, 30, 31). For convenience of description, the face which bears the lateral furrow is called ventral and its opposite dorsal.

The mature segments contain both sets of sexual organs. The external aperture is a genital cloaca. It is marginal and situated in the elongated mature segments a little in front of the middle. The cirrus is long and apparently smooth, except at the base, where it is beset with short curved spines (fig. 42). The male genital organs consist in general of the cirrus, which, when invaginated, is coiled into several folds in the cirrus pouch. The latter, together with the voluminous folds of the vas deferens, lies towards the median region of the segment in the sinus formed by the vagina. The testes develop within the central core of the strobile. They consist of spheroidal, granulo-nuclear bodies, often appearing as nests of nuclei, which occupy the whole inner core of the segment back to the germ glands, thus, in part, surrounding the cirrus pouch, vas deferens, vagina, and uterus, all of which lie in the central space, *i. e.*, the space which is inclosed by the thin layer of longitudinal and circular muscles.

The fine ducts which lead from the testes to the vas deferens have not yet been traced satisfactorily. A duct which is continuous with the voluminous folds of the vas deferens at the base of the cirrus pouch lies along the median line near the dorsal side of the segment (figs. 27, 29, *v. d.*).

The testicular lobes apparently communicate with this by means of fine tubules, but their disposition is not clearly shown in any of the sections. One of the lobes of the testis, in which there are spermatic cells and spermatozoa, is shown in fig. 39.

The following points on the arrangement of the female genitalia have been elucidated: The vagina opens in front of the cirrus in a common cloaca (figs. 34 and 35). Its course is thence forward and inward to the median line near the anterior end of the segment, thence posteriorly along the median line on the dorsal side of the uterus. Throughout its course it presents in sections a rugose interior surface (fig. 43). There are two enlargements of the cylindrical vaginal tube, one near the genital cloaca, from which the sketch shown in fig. 43 was made, the other near the posterior end of the segment in the midst of

the folds of the germ gland (see fig. 41). The vagina passes close to the shell gland (figs. 36 and 37) and continues in its course a short distance beyond that organ. Posterior to the shell gland it unites with the duct from the germ gland, and the common duct turns anteriorly to enter the posterior part of the shell gland. At the shell gland the common duct receives the duct from the vitelline gland. The vagina, thus reinforced, enters the shell gland at its posterior side and emerges from its anterior side as the oviduct. The latter proceeds forward for a short distance, then crosses from the dorsal to the ventral side of the segment, passing the vagina in its course and soon debouching into the uterus.[1]

The uterus is a conspicuous oblong organ, lying along the median line on the ventral side of the segment, and extending nearly to the anterior end of the segment. Its course and structure are shown in figs. 26, 27, 29, 30, 31, 40, and 41. The vitelline glands develop from the subcutaneous granulo-fibrous layer and consist of granulo-nuclear bodies, smaller than the lobes of the testis and lying mainly between the aquiferous vessels and the margins of the segment. The vitelline duct, which enters the duct leading to the shell gland, is made by the junction of two principal branches, one from each of the vitelline glands.

The relative positions of the various female sexual organs are shown in the diagrammatic sketch, fig. 41; some details of structure are shown in figs. 36, 37, 38, 42, and 43.

Along the ventral furrow the epidermis and cuticle are discontinuous and the uterus here lies near the surface. The furrow is probably a line of dehiscence through which, in ripe proglottides, the ova are discharged. Only the following observations have been made on the ova: Those which appear in the series of sections of a ripe proglottis prepared for this paper are small, about .014^{mm} in diameter, and without other shell than a thin, much shrunken membrane. Furthermore they seem to be held together in a common mesh of fibers which appear to be continuous with the membranous covering of the ova. In some of the sections of mature, not ripe, segments, the uterus contains numerous small, rounded, and fusiform masses of deeply stained granulo-nuclear materials, having the same general characters as the ova in the ripe proglottis (fig. 27).

The elongated unidentified proglottides mentioned above (p. 544) contain large ova which are long, oval, and have a definite resistant shell. They therefore evidently do not belong to this species.

EXPLANATION OF THE PLATES.

The following letters have the same significance in all figures:

c. m. circular muscles.
g. c. duct of germ gland.
g. g. germ gland.
l. longitudinal aquiferous vessel.
m. longitudinal muscles.
n. c. marginal nerve chord or vessel.
n. g. nerve cells.
o. v. oviduct.
p. cirrus.
s. c. subcuticular fibro-granular layer.
s. g. shell gland.
t. testis.
u. uterus.
v. vagina.
v. c. duct of vitelline gland.
v. d. vas deferens.
v. g. vitelline gland.

The figures are all from drawings by the author.

PLATE I.

FIG. 1. Scolex and pseudoscolex; *a*, scolex; *b*, pseudoscolex; *c*, anterior part of strobile; × about 14. From a stained alcoholic specimen.
FIG. 2. Detail of pseudoscolex, superficial view, × 27.
FIG. 3. View of another portion of same, × 27.
FIG. 4. Face of bothrium, viewed from the front so that the posterior part is slightly foreshortened; from alcoholic specimen, × about 60.
FIG. 5. Scolex and pseudoscolex of small specimen, from life, much enlarged; *a*, anterior loculus; *b*, hooks; *c*, posterior loculus; *d*, neck; *e*, pseudoscolex; *f*, anterior part of strobile.
FIG. 6. Front view of bothrium, from life, much enlarged.
FIG. 7. View of top of scolex and pseudoscolex, of large specimen, about one-half of the latter shown in sketch. Outline of pseudoscolex, × about 14 diameters; scolex, × 15. From stained alcoholic specimen; *a*, scolex.

PLATE II.

FIG. 8. Transverse section of scolex near apex through anterior loculi, × about 225. Picro-sulphuric preparation stained with Beale's carmine; *b*, loculus of bothrium; *m*, cut ends of longitudinal muscles. Nerve cells mainly central.
FIG. 9. Detail of transverse section through wall of bothrium, × 750.
FIG. 10. Transverse section through posterior loculi of bothria, × about 200 +; *l*, longitudinal vessels of water-vascular system, nerve cells no longer central as in fig. 8.
FIG. 11. Transverse section immediately back of scolex, × about 225. *l′*, branch of longitudinal aquiferous vessel entering cervical outgrowth of pseudoscolex; *m*, cut ends of longitudinal muscles. The nerves are here collected into the two marginal chords or vessels, *n. c*. *n. c*.
FIG. 12. Longitudinal section of bothrium, × about 225. *b*, anterior, *b′*, posterior loculus.
FIG. 12*a*. Bothrium treated with caustic potash, × 80. Front view.
FIG. 12*b*. Bothrium treated with caustic potash, × 80. Side view.
FIG. 13. Hook, optical section, showing the closely packed epithelial cells of which it is composed, from longitudinal section of bothrium, × 450.
FIG. 14. Longitudinal section of apex of scolex, showing central nerve mass, and vessels of water-vascular system; *b*, *b*, anterior loculi, × 450.
FIG. 15. Longitudinal section of apex of head showing nerve cells and longitudinal vessel of water-vascular system, section more nearly central than fig. 14, × 450.

All the figures of plate II, with the exception of 12*a* and 12*b*, made from picrosulphuric preparations stained with Beale's carmine (ammonia).

The plates here numbered I to VII follow page 556 and are there numbered LXI to LXVII.

PLATE III.

FIG. 16. Side view of scolex, from life, much enlarged.

FIG. 17. Transverse section of neck and pseudoscolex of small specimen, × about 50; *l*, longitudinal aquiferous vessels; *l'*, lateral branches of same in pseudoscolex; *a*, cervical outgrowth of pseudoscolex.

FIG. 18. Transverse section a little below middle of neck, × 200 +; *v*, transverse muscle fibers; other letters as in previous figures.

FIG. 19. Section made nearly longitudinally through anterior part of body, pseudoscolex and scolex of small specimen more nearly central than fig. 24. *a*, folds of pseudoscolex; *b*, anterior, *b'*, posterior loculus; × about 30.

FIG. 20. Transverse section of anterior part of body immediately back of pseudoscolex of small specimen, × about 32. In section from which this sketch was made pieces of the pseudoscolex folds surrounded the section of the body but were not attached to it; *c*, epidermis and cuticle; *d*, *d*, points where the longitudinal muscle layer *m* touches the cuticle. In the sections preceding this the longitudinal muscle fibers entered the cervical outgrowth of the pseudoscolex at these places; *s. c.*, subcuticular granulo-fibrous layer; *m*, longitudinal and *c. m.*, circular muscle layer; *l*, larger inner, *l'*, smaller outer aquiferous vessel; *n. c.*, nerve vessels lying near marginal extremities of central core.

All the figures on plate III with the exception of fig. 16, made from picro-sulphuric preparations stained with Beale's ammoniacal carmine.

PLATE IV.

FIG. 21. Details of Fig. 22: Transverse section immediately behind pseudoscolex of small specimen; *c*, epidermis; *c'*, cutis; *s. c.*, cuticular fibro-granular layer; *m.*, longitudinal muscles; *l*, larger aquiferous vessel, section through an abrupt fold of vessel; *l'*, smaller aquiferous vessel; *c. m.*, circular muscles; *n. c.*, nerve vessels. × about 225.

FIG. 21*a*. Details of epidermis: *e*, outer; *e'*, inner layer of epidermis; *c*, cutis; *s. c.*, subcuticular layer.

FIG. 22. Transverse section approaching posterior of pseudoscolex; small specimen, × about 50; *m'*, muscle fibers of the pseudoscolex continuous with the longitudinal muscles of the body.

FIG. 23. Longitudinal marginal section from middle of small specimen through larger aquiferous vessel. × 54. The longitudinal fibers of the subcutaneous layer are here visible.

FIG. 24. Longitudinal section a little inclined to the lateral face of the strobile through scolex and pseudoscolex; × about 30; *a*, cervical outgrowth of pseudoscolex near base; *b*, same near scolex; *l'*, aquiferous vessel; *c*, epidermis.

Fig. 23. From corrosive sublimate preparation stained in borax carmine; others, picro-sulph., Beale's carmine.

PLATE V.

FIG. 25. Diagrammatic sketch showing general plan of scolex and pseudoscolex of small specimen in section; l', lateral branch of aquiferous vessel; l'', plexus of aquiferous vessels; *aa*, sections of superficial folds of pseudoscolex; other letters as previously explained.

FIG. 26. Transverse section of posterior segment in which the sexual organs are mature, on level with posterior of genital cloaca; *l. f.*, lateral furrow; *p*, invaginated base of cirrus; *p'*, cirrus bulb with sections of coils of cirrus; other letters as previously explained; × about 36.

FIG. 27. Details of same in region of uterus and lateral fold; *c* inner, *c'* outer layer of epidermis; *c''*, cutis; *u*, uterus containing ova; other letters as previously explained; × 225.

FIG. 28. Details of fig. 26: Cirrus pouch; *e*, wall of cirrus pouch; *a* to *d*, different layers of invaginated cirrus; *m.*, longitudinal muscles, × 225.

FIG. 29. Transverse section of posterior segment with mature sexual organs, slightly more advanced than the one represented in fig. 30. Section made anterior to genital cloaca, × 45.

Figs. 26, 27, and 28, Perenyi's fluid preparation, Beale's carmine stain.
Fig. 29, Perenyi's fluid, Bömer's hæmatoxylon stain.

PLATE VI.

FIG. 30. Transverse section of posterior mature segment, near anterior end of segment, at extreme anterior end of uterus; *s*, portion of voluminous folds of vas deferens; other letters as in figs. 26, 29; × 45.

FIG. 31. Details of fig. 30; *u*, nuclear aggregation, first indication of the uterus; *s*, portion of folds of vas deferens with spermatozoa; *a*, epethelial glands, × 225.

FIG. 32. Longitudinal lateral section of small specimen, near anterior end through aquiferous and nerve vessels, × about 225.

FIG. 33. Superficial view of segments near posterior end. The apparent enlargement posteriorly is accidental, and would not appear in a longer portion of the strobile. As a rule the maturing segments become narrower; *a*, *a*, segments shaded to show characteristic roughened epidermis. From a stained alcoholic specimen.

FIG. 34. Longitudinal lateral section through genital cloaca, × 60.

FIG. 35. Longitudinal marginal section, posterior but not mature segment, × 260.

Figs. 30, 31, and 32, Picro-sulphuric, Beale's carmine.
Figs. 34 and 35, Perenyi's fluid, Bömer's hæmatoxylon.

PLATE VII.

FIG. 36. From transverse section of posterior segment with mature genital organs: posterior end of segment; germ gland, shell gland, etc.; × 112.

FIG. 37. Details of fig. 36, × 225.

FIG. 38. Transverse section of oviduct near the shell gland, from longitudinal section of posterior segment, × 475.

FIG. 39. Testicular body, with sperm cells, *a*, and spermatozoa, *b*, × 475.

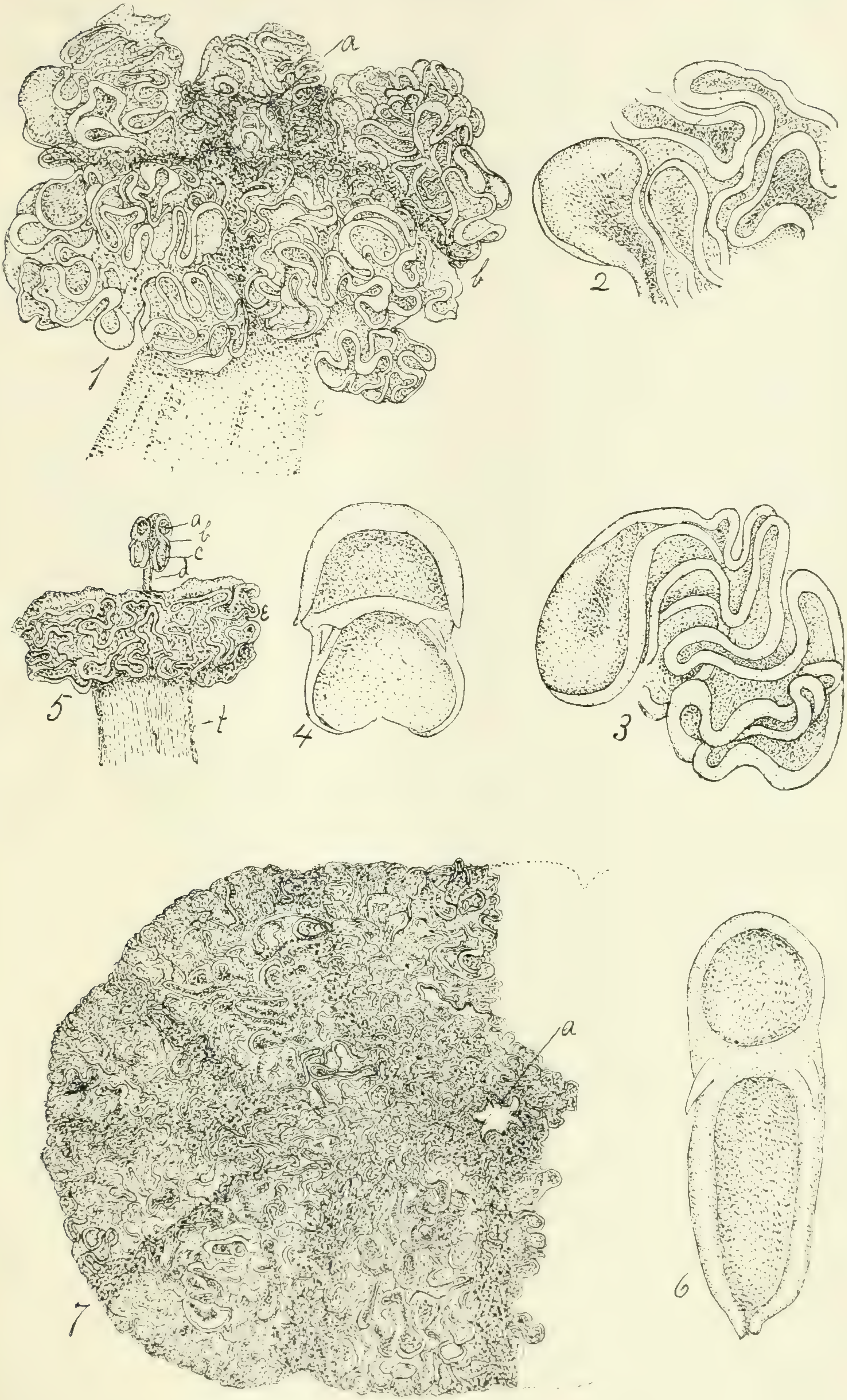
FIG. 40. Partly diagrammatic sketch of segment near posterior end of strobile, × 30

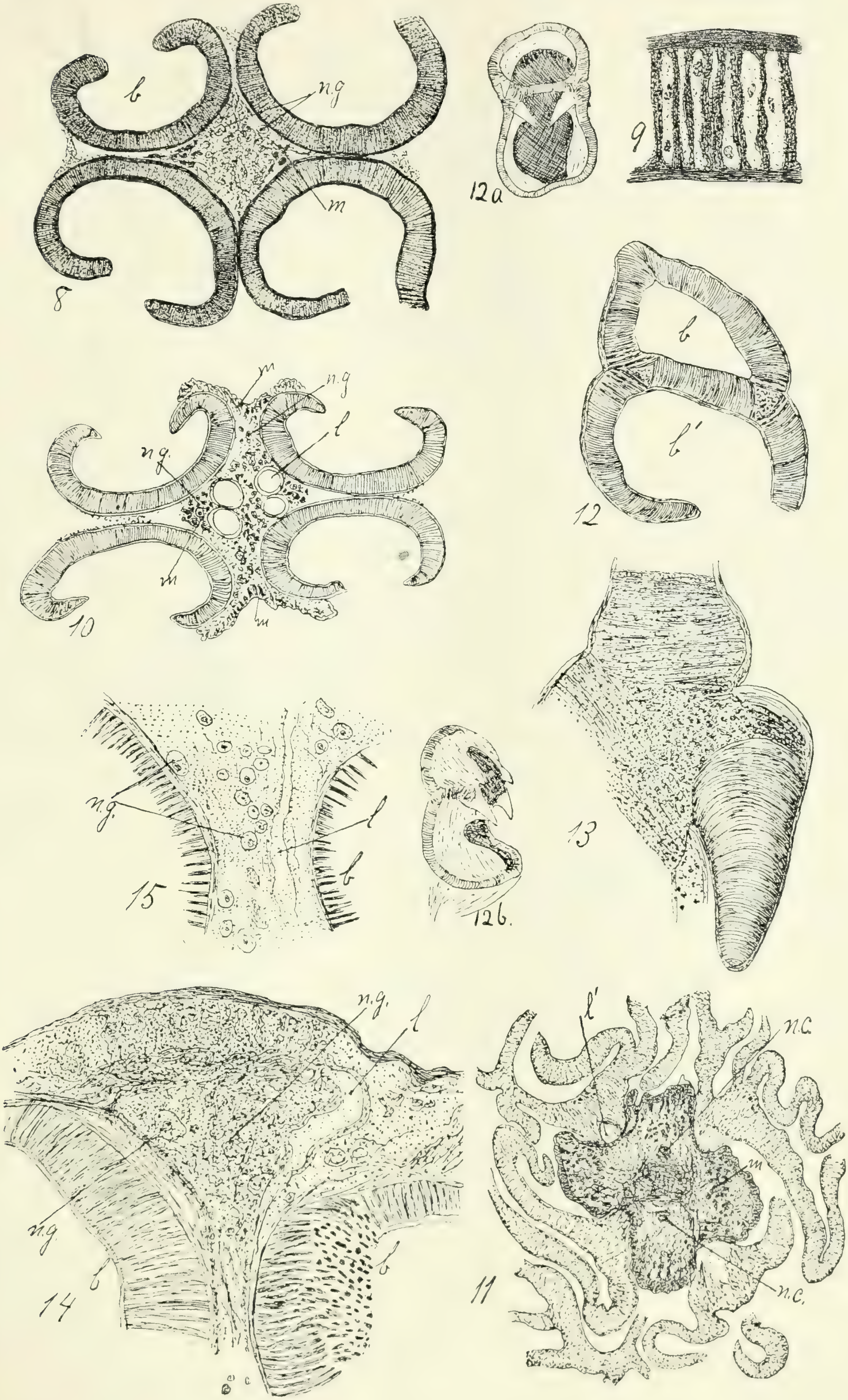
FIG. 41. Partly diagrammatic sketch showing female genitalia in mature segment × 30.

FIG. 42. Longitudinal section of invaginated cirrus, near base; the upper part o the figure is the marginal end; *a*, spines, × 225.

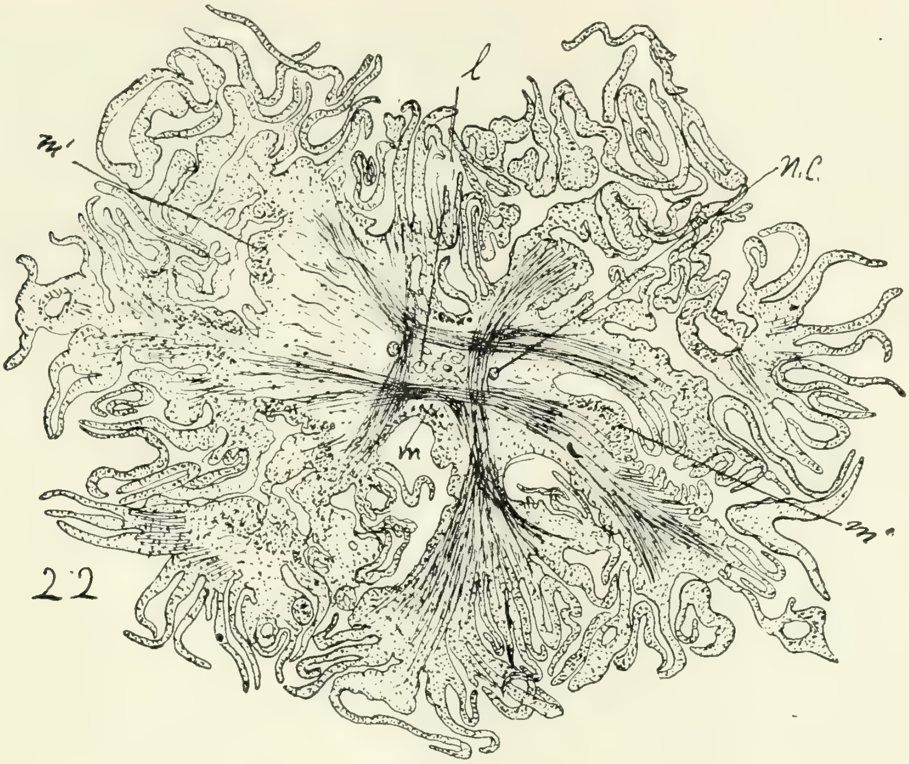
FIG. 43. Longitudinal section of vagina near genital cloaca; *a*, rugæ on wall o lumen, × 225.

Figs. 36, 37, 38, 39, and 41, Perenyi's fluid, Bömer's hæmatoxylon.
Figs. 40, 42, and 43, corrosive sublimate, borax-carmine preparations.

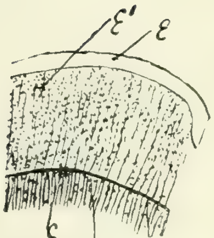

a
b
c
1
2
a
b
c
d
e
t
5
4
3
a
7
6



8
9
12a
10
12
13
15
12b.
14
11
b
n.g
m
l
b'
l'
n.c.

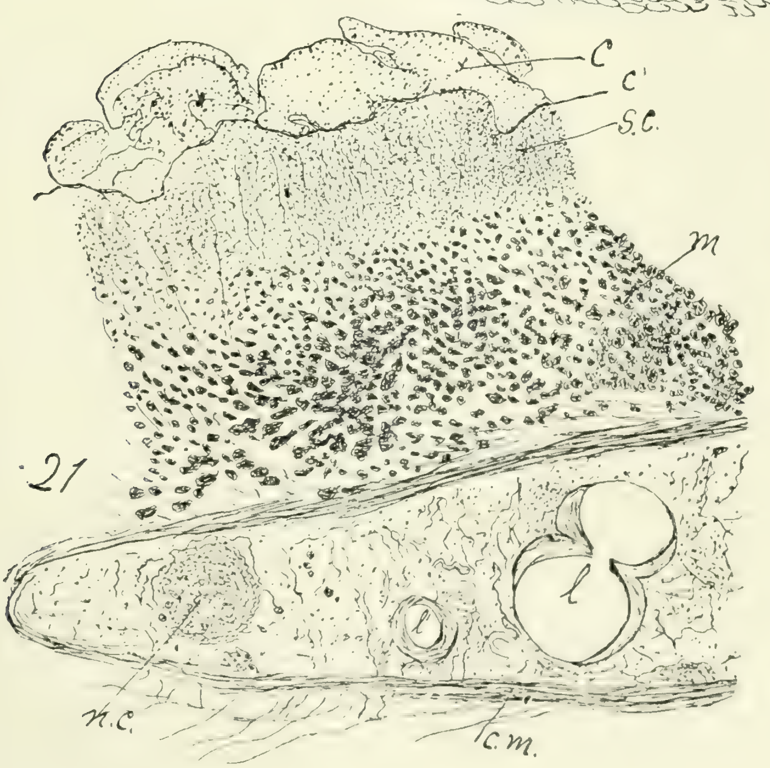


22

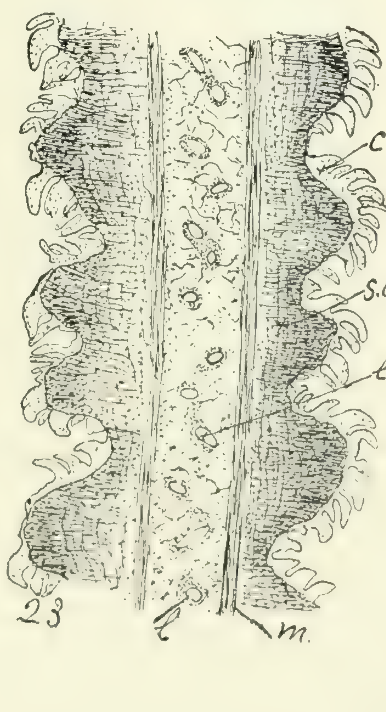


21a

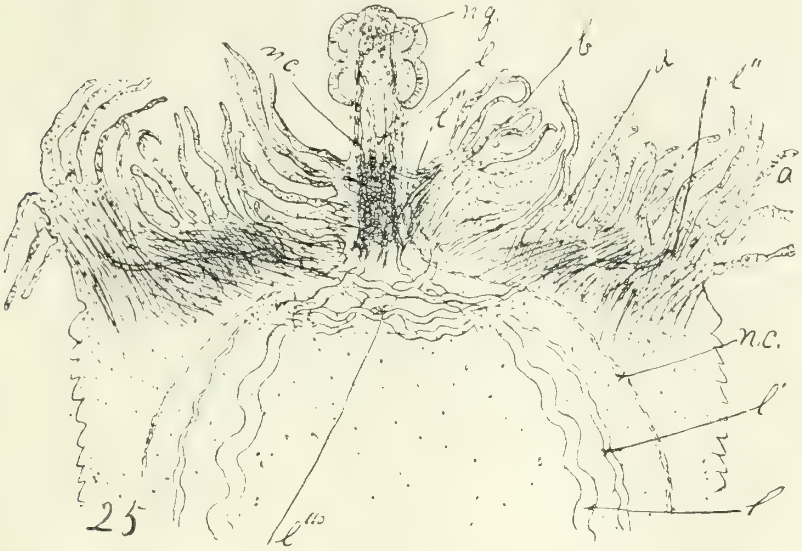
24

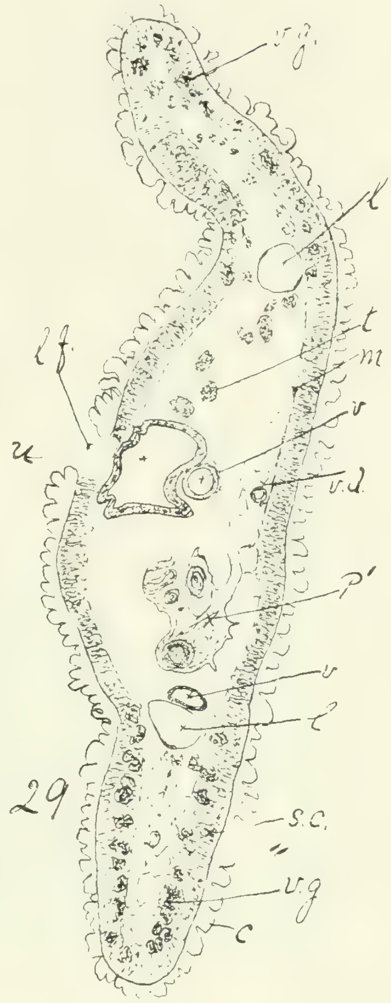


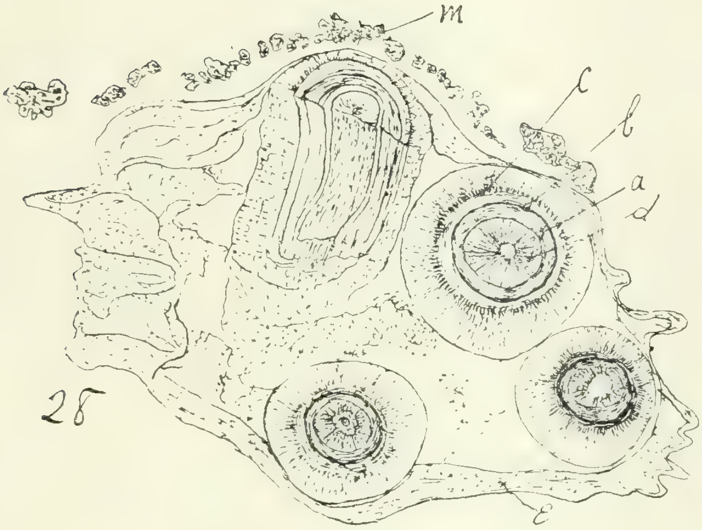
21



23

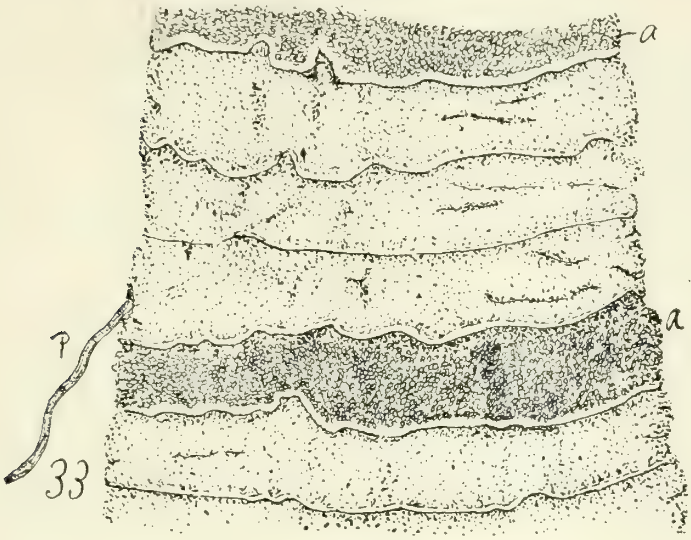

n.g.
nc
l
b
d
l''
a
n.c.
l'
l
l'''
25

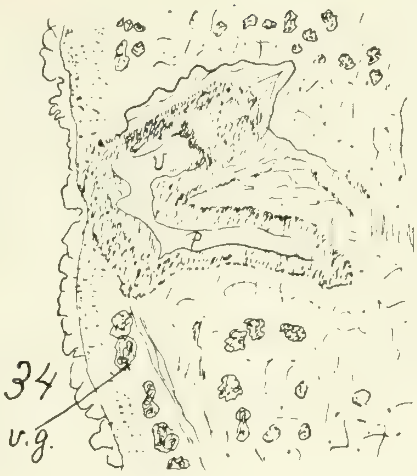

v.g.
l
t
m
l.f.
u
v
v.d.
p'
v
l
s.c.
v.g
c
29

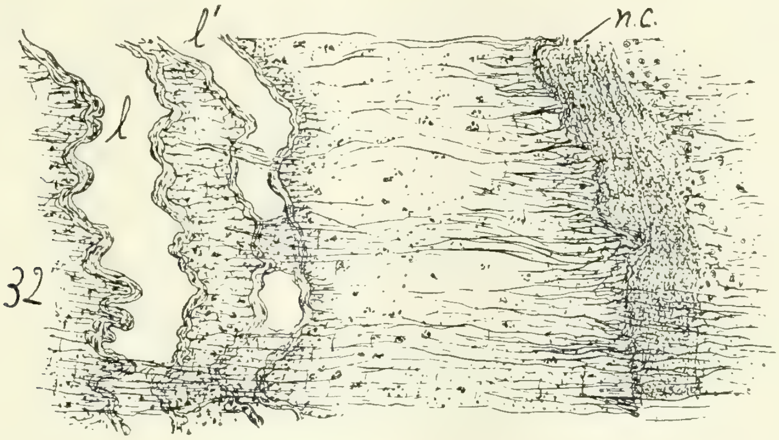

m
c
b
a
d
e
28

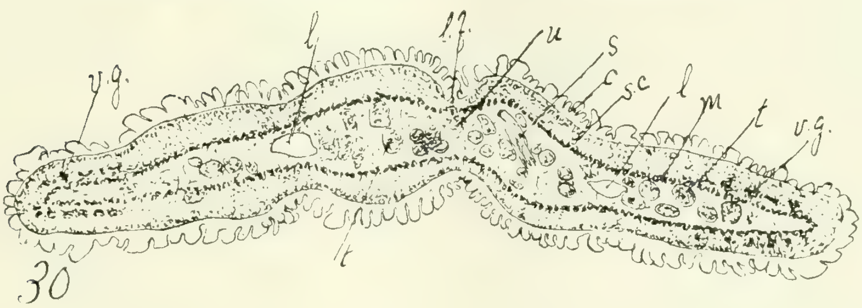

v.g.
l
t
s.c
c
u
m
l.f
v.
p
p
26


c'
c
l.f
c'
c
c''
s.c
m
c.m.
u
v
t
n.c
27

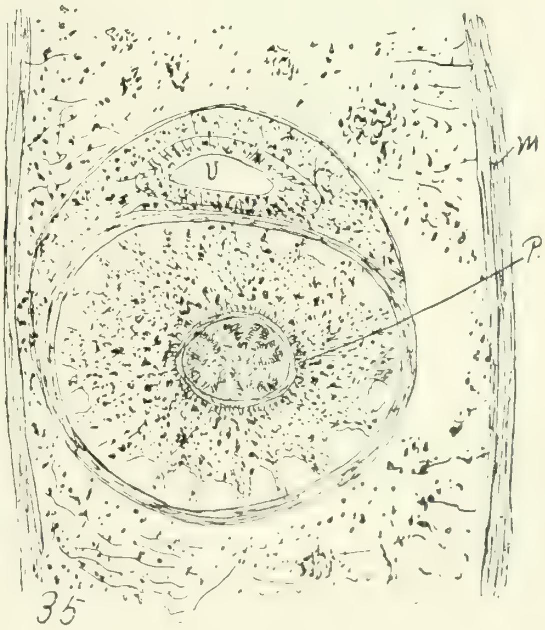

a
a
p
33

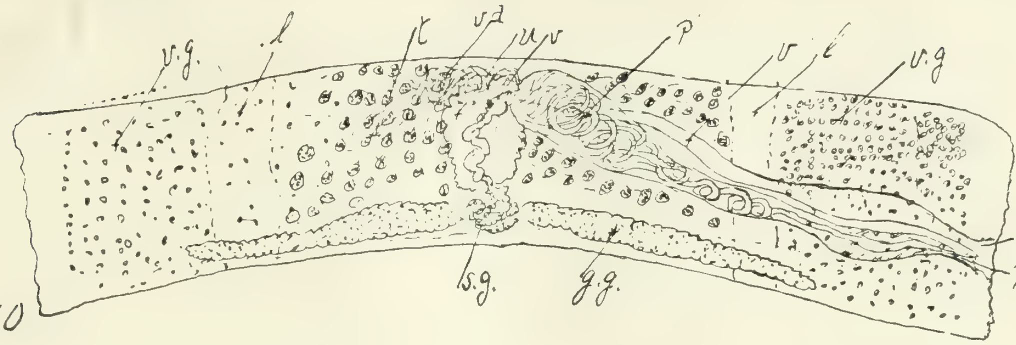

v
p
34
v.g.


l'
n.c.
l
32

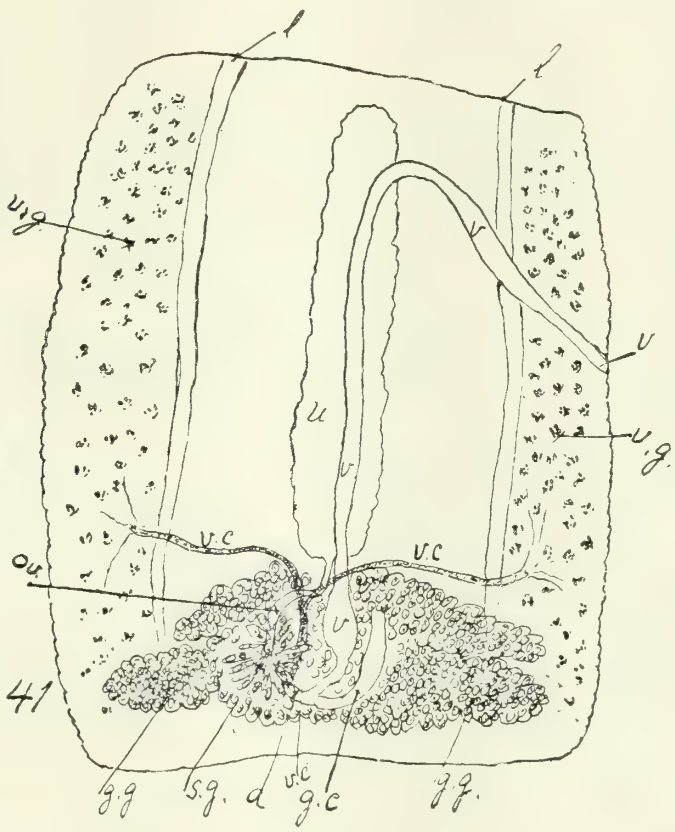

l
l.f.
u
s
c
s.c
l
m
t
v.g.
v.g.
lt
30


l.f.
c'
c
c"
s.c.
m
cm
a
t
s
31
m
u
c


m
v
P.
35

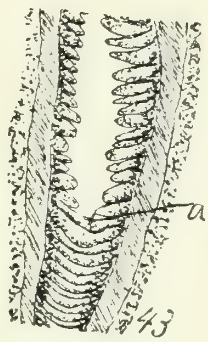


40



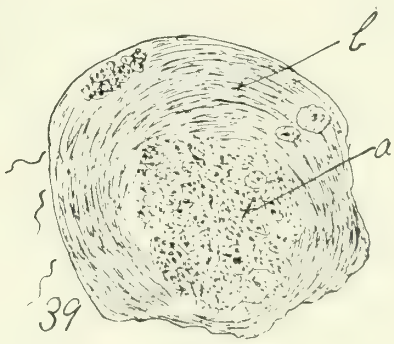
41

42

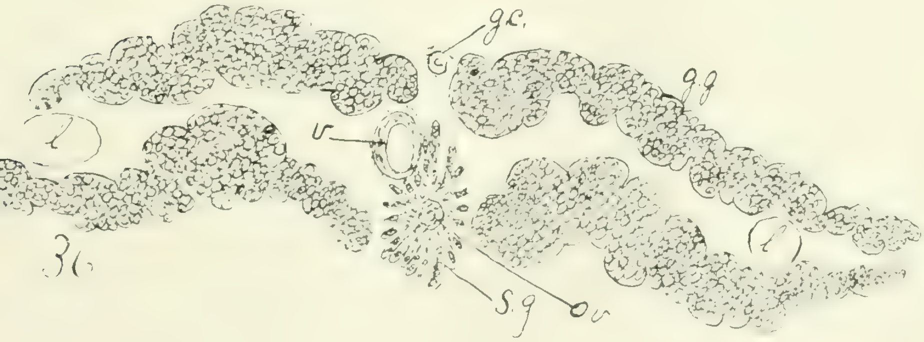


43

37



39



36

38

8.—A REVIEW OF THE CENTRARCHIDÆ, OR FRESH-WATER SUNFISHES, OF NORTH AMERICA.

By CHARLES HARVEY BOLLMAN, A. B.

NOTE.—The present paper was prepared at my suggestion by Mr. Bollman, and at his death it was found to be very nearly ready for the press. It is based on the collections made by the U. S. Fish Commission and on the material in the museum of the Indiana University. All the species of the family, with the exception of *Lepomis albulus* and the doubtful *Enneacanthus eriarchus*, have been examined by Mr. Bollman and most of his conclusions have been abundantly verified. It was Mr. Bollman's intention to add critical notes on the synonymy and observations of the habits of each species. The paper, even without these, will be useful to students of these fishes.

DAVID S. JORDAN.

In this paper are given analytical descriptions with an outline of the synonymy of the different species of the *Centrarchidæ*, popularly known as sunfishes, pond fishes, crappies, pumpkin-seeds, and black bass. This group is recognized, as currently defined, as a family of percoid fishes closely allied to the *Serranidæ*, being distinguished chiefly by the rudimentary condition of the pseudobranchiæ and certain peculiarities in the form of the body. The definition given by Jordan and Gilbert (Synopsis of the Fishes of North America, 1883, p. 462) may be accepted for the purposes of this paper. All the species are confined to the fresh waters of North America. They are especially abundant in the lowland rivers, lakes, and ponds of the eastern United States, where they form one of the most conspicuous elements in the fish fauna. All are carnivorous fishes, and all that are large enough to be worth considering are excellent as food.

The group has been divided by Dr. Gill into three subfamilies very closely related to each other, *Centrarchinæ*, *Lepominæ*, and *Micropterinæ*. Most of the species belong to the *Lepominæ*. The *Micropterinæ* approach most nearly to the *Serranidæ*, and are perhaps most nearly related to the primitive stock from which the group has sprung.

The chief characters of these subfamilies, as well as of the different genera, are given in the following analysis:

ANALYSIS OF THE GENERA OF CENTRARCHIDÆ.

a. Dorsal fin scarcely larger than anal. (CENTRARCHINÆ.)
  b. Dorsal spines, 11 or 12; anal spines, 7 or 8; spinous dorsal longer than soft dorsal; body short and deep, compressed..CENTRARCHUS, 1.
  bb. Dorsal spines, 5 to 8; anal spines, 6; spinous dorsal shorter than soft dorsal; body elongate, compressed....................POMOXIS, 2.
aa. Dorsal fin much larger than anal.
  c. Body rather short and deep; dorsal fin not deeply divided. (LEPOMINÆ.)
    d. Tongue and pterygoids with teeth.
      e. Scales ctenoid; caudal emarginate.
        f. Anal spines, 5 to 8; operculum emarginate behind.
          g. Lingual teeth in two patches; gill-rakers about 20; most of the membrane bones of head serrate; lower point of opercle striate, striæ ending in sharp points.......ARCHOPLITES, 3.
          gg. Lingual teeth in a single patch; gill-rakers about 10; only the preopercle serrate at its angle, bones of head otherwise entire; lower point of opercle without pointed striæ. AMBLOPLITES, 4.
        ff. Anal spines, 3; operculum ending in a black convex flap; preopercle entire; dorsal spines, 10...............CHÆNOBRYTTUS, 5.
      ee. Scales cycloid; caudal convex; anal spines, 5......ACANTHARCHUS, 6.
    dd. Tongue and pterygoids toothless; mouth small; preopercle entire.
      h. Operculum emarginate; caudal fin convex.
        i. Dorsal fin continuous.....................ENNEACANTHUS, 7.
        ii. Dorsal fin angulated.....................MESOGONISTIUS, 8.
      hh. Operculum more or less prolonged behind into a convex flap; caudal fin emarginate..........................LEPOMIS, 9.
  cc. Body elongate; dorsal fin low, deeply emarginate. (MICROPTERINÆ.) MICROPTERUS, 10.
        j. Mouth large; maxillary with a supplemental bone; opercle emarginate behind; preopercle entire; lower pharyngeals narrow, with sharp teeth; caudal lunate.

I. CENTRARCHUS.

1829. **Centrarchus** Cuvier & Valenciennes, Hist. Nat. Poiss., III, 62 (*irideus*).
1864. **Eucentrarchus** Gill, Amer. Jour. Sci. and Arts, 92 (*irideus*).

Type: *Labrus irideus* Lacépède.

Etymology: *Κέντρον*, spine; *ἀρχός*, anus.

ANALYSIS OF THE SPECIES OF CENTRARCHUS.

a. Body ovate, strongly compressed; head small; snout short, shorter than eye; mouth small, oblique; maxillary reaching posterior border of pupil; eye large, 3¼ to 4 in head; opercular spot narrow, much higher than long; scales large, 4 to 6 rows on cheeks; dorsal high, longest spine 1⅔ in head; pectorals and ventrals long, reaching anal, ventral spines extending past anus to fin. Green, with series of dark brown spots on sides, below lateral line forming interrupted longitudinal lines; a dark spot below eye; soft dorsal and anal reticulated; young with a black ocellus at base of soft dorsal. Head, 2⅔ to 3; depth, 1⅞ to 2. D. XI–XII, 12; A. VII–VIII, 15; lat. l., 38 to 44; L. 6 inches..................MACROPTERUS, 1.

1. CENTRARCHUS MACROPTERUS.

(Round Sunfish. Plate LXVIII, fig. 1.)

Labrus macropterus Lacépède, Hist. Nat. Poiss., III, 447, 1802 (Charleston).
Centrarchus macropterus Jordan, Bull. x, U. S. Nat. Mus., 36, 1877.
Labrus irideus Lacépède, Hist. Nat. Poiss., IV, 716, 1802 (Charleston).
Centrarchus irideus Cuv. & Val., Hist. Nat. Poiss., III, 89, 1829 (Carolina).

Habitat: Lowland streams from southern Virginia southward to Florida and Louisiana; northward in the Mississippi Valley to Illinois.

Etymology: *Μακρός*, long; *πτερόν*, fin.

This species is generally common in the bayous and ponds of the southern streams.

II. POMOXIS.

1818. **Pomoxis** Rafinesque, Journ. Acad. Nat. Sci. Phila., 417 (*annularis*).
1860. **Pomoxys** Holbrook, Ich. S. C., 29 (*emend.*).
1864. **Hyperistius** Gill, Amer. Journ. Sci. and Arts, 92 (*hexacanthus*).

Type: *Pomoxis annularis* Rafinesque.

Etymology: *Πῶμα*, opercle; *ὀξύς*, sharp.

ANALYSIS OF THE SPECIES OF POMOXIS.

a. Dorsal spines, 7, rarely 8; anal strongly reticulated; body oblong, elevated, much compressed; head moderate; snout projecting; mouth rather large; maxillary reaching to posterior border of eye; eye large, 3½ to 4 in head; opercular spot small; dorsal elevated, longest spine reaching posterior border of eye; pectorals and ventrals reaching anal, ventral spine extending past anus; scales moderate, 6 to 8 rows on cheeks. Silvery-olive, mottled with clear green; dorsal and anal marked alike; head, 3; depth, 2; D. VII or VIII, 15; A. VI, 17 or 18; lat. l., 40 to 45. SPAROIDES, 2.

aa. Dorsal spines 6, rarely 5; anal, plain; profile of head more strongly S-shaped than in *sparoides;* nape more gibbous; snout longer than eye; maxillary somewhat shorter; eye smaller, 4½ to 5 in head; scales on cheeks in 4 or 5 rows; lat. l., 36 to 48; rest almost as in *sparoides* .... ANNULARIS, 3.

2. POMOXIS SPAROIDES.

(Calico Bass; Strawberry Bass; Tin-mouth; Grass Bass; Bar Fish. Pl. LXVIII, fig. 2.)

Labrus sparoides Lacépède, Hist. Nat. Poiss., III, 517, 1802.
Centrarchus sparoides Cuv. & Val., III, 88, 1829 (Carolina).
Pomoxis sparoides Girard, U. S. Pac. R. R. Surv., 6, 1859.
Cantharus nigromaculatus Le Sueur MS., 1829 (Cuv. & Val., Hist. Nat. Poiss., III, 88).
Pomoxis nigromaculatus Girard, U. S. Pac. R. R. Surv., 6, 1859.
Centrarchus hexacanthus Cuv. & Val., Hist. Nat. Poiss., VII, 458, 1831.
Pomoxys hexacanthus Holbrook, Ich. S. C., 29, 1860.
Hyperistius hexacanthus Gill, Amer. Jour. Sci. and Arts, 97, 1864.
Hyperistius carolinensis Gill, Amer. Jour. Sci. and Arts, 92, 1864.

Habitat: Eastern United States from the Great Lakes to the Gulf, east to the Hudson River, west to Arkansas; in upland streams and lakes, rarely descending to the lowlands.

Etymology: *Sparus*, a genus of fishes; *εἶδος*, like.

3. POMOXIS ANNULARIS.

(Crappie; Sac-a-Lai; Bachelor; New Light. Plate LXVIII, fig. 3.)

Pomoxis annularis Rafinesque, Amer. Mont. Mag., 41, 1818 (Falls of Ohio River).
Pomoxys annularis Jordan, Man. Vert., ed. 1, 231, 1876.
Cichla storeria Kirtland, Rep. Zool. Ohio, 191, 1838.
Pomoxys storerius Gill, Proc. Acad. Nat. Sci. Phila., 1865, 64.
Pomoxis nitidus Girard, Proc. Acad. Nat. Sci. Phila. 1857 (Houston River, Ky.).
Centrarchus nitidus Günther, Cat. Fish. Brit. Mus., I, 257, 1859.
Pomoxys brevicauda Gill, Proc. Acad. Nat. Sci. Phila. 1865, 64 (North Grand River, Mo.).
Pomoxys intermedius Gill, Proc. Acad. Nat. Sci. Phila. 1865, 64.
Pomoxys protacanthus Gill, Proc. Acad. Nat. Sci. Phila. 1865, 64 (Tarboro, N. C.).

Habitat: Eastern United States south of the Great Lake region, east of the Alleghanies north to the Great Lakes, west to Kansas and Texas (in lowland streams).

Etymology: Latin, ringed.

III. ARCHOPLITES.

1861. **Archoplites** Gill, Proc. Acad. Nat. Sci. Phila., 165 (*interruptus*).

Type: *Centrarchus interruptus* Girard.

Etymology: *'Αρχός*, anus; *ὁπλίτης*, armed.

ANALYSIS OF THE SPECIES OF ARCHOPLITES.

a. Body oblong ovate, compressed, profile angulated; head large; snout scarcely longer than eye; mouth large; maxillary reaching posterior border of eye; eye moderate, $4\frac{1}{2}$ to 5 in head; scales moderate, smaller on breast and back, 8 to 9 rows on cheeks; dorsal spines rather high, longest reaching posterior border of pupil; pectorals and ventrals not reaching anal. Blackish above, sides silvery, with about 7 dark interrupted bars; a black opercular spot; fins nearly plain; head, $2\frac{2}{3}$ to $2\frac{4}{5}$; depth, $2\frac{1}{4}$ to $2\frac{1}{2}$; D. XII–XIII, 10; A. VI–VII, 10; lat. l., 40 to 51; L., 12 inches.................................INTERRUPTUS, 4.

4. ARCHOPLITES INTERRUPTUS.

(Sacramento Perch. Plate LXIX, fig. 1.)

Centrarchus interruptus Girard, Proc. Acad. Nat. Sci. Phila. 1854. 129 (San Joaquin and Sacramento Rivers).
Ambloplites interruptus Girard, U. S. Pac. R. R. Surv., 10, 1859.
Archoplites interruptus Gill, Proc. Acad. Nat. Sci. Phila. 1861, 165.
Centrarchus maculosus Ayres, Proc. Cal. Acad. Nat. Sci. 1854, 8.

Habitat: Sacramento and San Joaquin Rivers, California.

Etymology: Latin, interrupted.

This species is common in the larger streams of California and is the only Percoid west of the Rocky Mountains.

IV. AMBLOPLITES.

1820. **Ambloplites** Rafinesque, Ich. Oh., 33 (*ictheloides = rupestris*).

Type: *Lepomis ictheloides* Raf. (= *Bodianus rupestris*).

Etymology: Ἀμβλύς, blunt; ὁπλίτης, armed.

ANALYSIS OF THE SPECIES OF AMBLOPLITES.

a. Scales on cheeks not rudimentary; body oblong, heavy, moderately compressed; head large; snout projecting, shorter than eye; mouth large; maxillary reaching to posterior border of eye; opercular spot small, black, confined; eye large, 3½ to 4 in head; scales large, 6 to 8 rows on cheeks; dorsal spines moderately elevated, longest reaching to posterior border of pupil; ventrals and pectorals not reaching anal, ventral spine 1⅓; olive green, tinged with brassy; a dark spot on each scale, these forming interrupted long stripes; a dark spot below eye; vertical fins reticulated; head, 2½ to 2¾; depth, 2 to 2½; D. XI, 10; A. VI, 10; lat. l., 38 to 42; L., 12 inches..RUPESTRIS, 5.

aa. Scales on cheeks rudimentary in the adult (stripes more interrupted and fins less reticulated), otherwise as in *rupestris* ....CAVIFRONS, 5*b*.

5. AMBLOPLITES RUPESTRIS.

(Rock Bass; Red Eye. Plate LXIX, fig. 2.)

Bodianus rupestris Rafinesque, Amer. Mont. Mag., 120, 1817.
Ambloplites rupestris Gill, Proc. Acad. Nat. Sci. Phila. 1860, 20.
Icthelis erythrops Rafinesque, Ich. Oh., 29, 1829 (Ohio River).
Lepomis ictheloides Rafinesque, Ich. Oh., 32, 1819 (Ohio River).
Ambloplites ichtheloides Agassiz, Amer. Journ. Sci. and Arts, 299, 1854 (Huntsville, Ala.).
Cichla ænea Le Sueur, Journ. Acad. Nat. Sci. Phila. 1822, 214.
Centrarchus æneus Cuv. & Val., Hist. Nat. Poiss., III, 84, 1829 (Lake Ontario).
Ambloplites æneus Agassiz, Amer. Journ. Sci. and Arts, 299, 1854.
Centrarchus pentacanthus Cuv. & Val., Hist. Nat. Poiss., III, 88, 1829 (Wabash R.).

Habitat: Lake Champlain to Manitoba, south to Louisiana in rivers and lakes west of the Alleghany Mountains.

Etymology: Latin; living among rocks.

5b. AMBLOPLITES RUPESTRIS CAVIFRONS.

Ambloplites cavifrons Cope, Journ. Acad. Nat. Sci. Phila. 1868, 217 (Roanoke R.).

Habitat: Roanoke River.

Etymology: *Cavus*, hollow; *frons*, forehead.

An examination of an adult of this form from Roanoke River shows that *cavifrons* should probably be maintained as a distinct subspecies. There is nothing peculiar or different in any respect from *rupestris* about the physiognomy of *cavifrons*, the sole tangible difference being in the scaling of the head.

V. CHÆNOBRYTTUS.

1864. **Chænobryttus** Gill, Amer. Journ. Sci. and Arts, 92 (*Calliurus melanops* Girard).

1876. **Glossoplites** Jordan, Man. Vert., ed. I, 223 (*melanops*).

Type: *Calliurus melanops* Girard (=*Pomotis gulosus* Cuv. & Val.)

Etymology: *Χαίνω*, to yawn; *bryttus*, *i. e.*, *lepomis*.

ANALYSIS OF THE SPECIES OF CHÆNOBRYTTUS.

a. Body elongate, heavy, short and thick; head large; snout about equal to eye; mouth large; maxillary reaching posterior border of eye; eye large, 4 to $4\frac{1}{2}$ in head; opercular spot about as large as eye, black confined, margined; scales moderate, 6 to 8 rows on cheeks; dorsal spines low, largest reaching to middle of pupil; pectorals not reaching anal; ventrals nearly reaching anus, ventral spine about 2 in distance between origin of ventrals and anus. Dark olive-green, sides brassy, with numerous blotches of blue and coppery red; belly yellow, spotted with red; iris bright red; 3 or 4 dark-red bars back and below eye across cheeks and opercles; vertical fins reticulated; soft dorsal and anal with a faint spot. Head, $2\frac{1}{2}$ to $2\frac{2}{3}$; depth, 2 to $2\frac{1}{4}$; D. x, 10; A. III, 9; lat. l., 38 to 44; L., 10 inches. GULOSUS, 6.

6. CHÆNOBRYTTUS GULOSUS.

(War-mouth. Plate LXIX, fig. 3.)

Pomotis gulosus Cuv. & Val., Hist. Nat. Poiss., III, 498, 1829 (New Orleans).
Centrarchus gulosus Cuv. & Val., Hist. Nat. Poiss., VII, 459, 1831.
Calliurus gulosus Agassiz, Amer. Journ. Sci. and Arts, 300, 1854 (Huntsville, Ala.).
Chænobryttus gulosus Cope, Proc. Acad. Nat. Sci. Phila., 1865, 84 (Michigan).
Lepomis gulosus Cope, Journ. Acad. Nat. Sci. Phila. 1868, 223.
Centrarchus viridis Cuv. & Val., Hist. Nat. Poiss., VII, 460, 1831 (New Orleans).
Chænobryttus viridis Jordan and Copeland, Bull. Buff. Soc. Nat. Hist., 137, 1876.
Calliurus punctulatus Agassiz, Amer. Journ. Sci. and Arts, 300, 1854 (Huntsville, Alabama).
(?) *Pomotis pallidus* Agassiz, l. c., 1854 (Huntsville, Alabama).
Calliurus floridensis Holbrook, Journ. Acad. Nat. Sci. Phila. 1855, 53 (St. John's River, Florida).
Bryttus floridensis Günther, Cat. Fish. Brit. Mus., 260, 1859.
Chænobryttus floridensis Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 137, 1876.
Calliurus melanops Girard, Proc. Acad. Nat. Sci. Phila. 1857 (Leon River, Rio Medina, Dry Creek, and San Pedro Creek, Texas).
Bryttus melanops Günther, Cat. Fish. Brit. Mus., 260, 1859.
Chænobryttus melanops Gill, Amer. Journ. Sci. and Arts, 92, 1864.
Glossoplites melanops Jordan, Man. Vert., 223, 1876 (Illinois River).
Lepomis gillii Cope, Journ. Acad. Nat. Sci. Phila. 1868, 225 (James River, Va.).
Chænobryttus gillii Cope, Proc. Amer. Phil. Soc., 425, 1870. (All streams of North Carolina east of the Alleghanies; not found in the French Broad).
Glossoplites gillii, Jordan, Man. Vert., ed. I, 233, 1876.
Chænobryttus gillii Cope, Proc. Amer. Phil. Soc., 252, 1870 (French Broad).
Lepomis charybdis Cope, Journ. Acad. Nat. Sci. Phila. 1868, 224 (Texas).
Chænobryttus antistius McKay, Proc. U. S. Nat. Mus. 1881, 88 (Lake Michigan).
Chænobryttus gulosus antistius Jordan, Cat. Fish. N. A., 76, 1885.
? *Lepomis lirus* McKay, Proc. U. S. Nat. Mus., 1881, 89 (based on *Pomotis pallidus* Agassiz).

Habitat: Eastern United States from the Great Lakes to Virginia, southwest to the Gulf; east of the Alleghanies; north to Virginia; west to Kansas and Texas.

Etymology: Latin; big mouthed.

I have been unable to find any stable differences between the *antistius* of McKay and the *gulosus* of Cuv. and Val. The differences mentioned in Jordan and Gilbert's Synopsis gradually fade into each other, and all the many specimens of war-mouth examined doubtless belong to one species. The *Pomotis pallidus* of Agassiz, which has become the *Lepomis lirus* of McKay, I can not identify, and I suggest that it may be the same as *Chænobryttus gulosus.*

VI. ACANTHARCHUS.

1864. **Acantharchus** Gill, Amer. Journ. Sci. and Arts, 92 (*pomotis*).

Type: *Centrarchus pomotis* Baird.

Etymology: *Ἄκανθα*, spine; *ἀρχός*, anus.

ANALYSIS OF THE SPECIES OF ACANTHARCHUS.

a. Body oblong, robust, moderately compressed; head large; snout shorter than eye; mouth large; maxillary extending past eye, $2\frac{1}{5}$ in head; eye moderate, 4 to $4\frac{1}{2}$ in head; opercular spot smaller than eye; scales moderate, 5 to 6 rows on cheeks; dorsal spines low, longest reaching to middle of pupil; ventral and pectorals reaching anal, the latter short, $1\frac{1}{2}$ in head, ventral spine $1\frac{3}{4}$ in distance between origin of ventrals and anus. Dark greenish, usually with five longitudinal black bands along sides; cheeks with three dark bars; vertical fins dark at base; head $2\frac{1}{2}$ to $2\frac{2}{3}$; depth, 2 to $2\frac{1}{2}$; D. XI, 10; A. V, 10; lat. l., 38 to 44 .... POMOTIS, 7.

7. ACANTHARCHUS POMOTIS.

(Mud Bass. Plate LXX, fig. 1.)

Centrarchus pomotis Baird, Ninth Smith. Rept., 325, 1854 (New Jersey, New York).
Acantharchus pomotis Gill, Amer. Journ. Sci. and Arts, 92, 1864.

Habitat: East of the Alleghany Mountains, from New York to South Carolina, only in the lowland streams.

Etymology: *Pomotis*, an old name of *Lepomis.*

VII. ENNEACANTHUS.

1864. **Enneacanthus** Gill, Amer. Journ. Sci. and Arts, 92 (*obesus*).
1868. **Hemioplites** Cope, Journ. Acad. Nat. Sci. Phila., 218 (*simulans=gloriosus.*)
1877. **Copelandia** Jordan, Proc. Acad. Nat. Sci. Phila., 56 (*eriarcha*).

Type: *Pomotis obesus* Baird.

Etymology: *Ἐννέα*, nine; *ἄκανθα*, spine.

ANALYSIS OF THE SPECIES OF ENNEACANTHUS.

a. Opercular spot large, more than half eye; sides with 5 to 8 distinct vertical bars; body oblong-ovate, compressed; head small; snout shorter than eye; mouth small; maxillary extending to middle of pupil; eye large, 3 to $3\frac{1}{2}$ in head; opercular spot bordered below, black not confined; scales moderate, 3 to 4 rows on cheeks; dorsal moderately high; longest spine extending beyond pupil; pectorals and ventrals reaching anal, ventral spine reaching anus. Olivaceous, with 5 to 8 distinct black crossbars; spots on body or fins purplish or golden; cheeks with lines and spots; a dark bar below eye; head $2\frac{2}{3}$ to 3; depth, $1\frac{1}{2}$ to $2\frac{1}{4}$; D. IX, 10; A. III, 10; lat. l., 32 to 33; L., 3 inches.
OBESUS, 8.

aa. Opercular spot smaller than half eye; body without crossbars.

b. Ventral spines reaching anus; body more robust and elongated than in *obesus*; dark olive; sides of head, whole body, and vertical fins, in the males, with round, bright, blue spots arranged in irregular rows; females duller, with larger and fainter spots more regular in position; ear flap small, with a blue border and a pearly spot in front; a dark bar below eye; D. IX to X, 10; A. III to IV, 9; lat. l., 30 .... GLORIOSUS, 9.

bb. [Ventral spines reaching anal. Olivaceous; vertical fins with round, pale spots; D. X, 7; A. IV, 8; lat. l., 33; doubtful species, probably identical with *gloriosus* .... ERIARCHUS, 10.]

8. ENNEACANTHUS OBESUS.

Pomotis obesus Baird, Ninth Smith. Rept., 324, 1854 (Beaseley's Point, N. J.).
Bryttus obesus Girard, Proc. Acad. Nat. Sci. Phila. 1859, 53.
Enneacanthus obesus Gill, Amer. Journ. Sci. and Arts, 92, 1864.
Bryttus fasciatus Holbrook, Jour. Ac. Nat. Sci. Phila. 1855, 51 (St. John's R., Fla.).
Enneacanthus fasciatus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 137, 1876.
Pomotis guttatus Morris, Proc. Acad. Nat. Sci. Phila. 1859, 3 (Philadelphia).
Enneacanthus milnerianus Cope MS. 1878 (description never published).

Habitat: Massachusetts to Florida, in lowland streams.

Etymology: Latin; *obesus*, fat.

9. ENNEACANTHUS GLORIOSUS.

Bryttus gloriosus Holbrook, Journ. Acad. Nat. Sci. Phila. 1855, 51 (Cooper River, S. C.; Georgia).
Enneacanthus gloriosus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 137, 1876.
Hemioplites simulans Cope, Journ. Acad. Nat. Sci. Phila. 1868, 218 (Tuckahoe Creek, near Richmond, Va.).
Enneacanthus simulans McKay, Proc. U. S. Nat. Mus., 93, 1881.
Enneacanthus pinniger Jordan, Bull. X, U. S. Nat. Mus., 27 1878 (Kinston, N. C.).
Enneacanthus simulans pinniger Jordan, Cat. Fish. N. A., 76, 1885.
Enneacanthus margarotis Gill & Jordan, Bull. X, U. S. Nat. Mus., 28, 1878 (Beaseley's Point, N. J.).

Habitat: New Jersey to Florida, in lowland streams, east of the mountains.

Etymology: Latin; *gloriosus*, glorious.

A careful comparison of specimens of *E. simulans*, with Holbrook's description of *Bryttus gloriosus*, convinces me that they are the same, and as *gloriosus* is an older name it must be used in place of *simulans*. *Enneacanthus simulans pinniger* is not worthy even of a subspecific rank, as the characters upon which it is based are very variable, and are those of highly developed males. In this point I agree with Mr. Charles L. McKay (Proc. U. S. Nat. Mus. 1881, 92).

10. ENNEACANTHUS ERIARCHUS.

Copelandia eriarcha Jordan, Proc. Acad. Nat. Sci. Phila. 1877, 56 (Menonomee River, Milwaukee, Wisconsin).
Enneacanthus eriarchus McKay, Proc. U. S. Nat. Mus. 1881, 93.

Habitat: Unknown. The assigned localities are the Menonomee River, Wisconsin, and Missouri.

Etymology: Ἐρι, an intensive particle; ἀρχός, anus.

This is a very doubtful species, but it may be retained provisionally as distinct, on the characters given in the key, which are those of the original type. Both the localities assigned to this species are probably erroneous. The original type was sent to the Indiana University by Dr. P. R. Hoy, purporting to have come from the neighborhood of Milwaukee. Another smaller specimen is in the National Museum, said to have been taken by Dr. Hoy in Tabo Creek, Missouri. Inasmuch as no other collector has obtained any *Enneacanthus* west of the Alleghany Mountains, it is probable that Dr. Hoy's specimens came from some eastern locality.

E. eriarchus is probably identical with *E. gloriosus*, the frequent variation in number of spines in the latter species being additional reason for so thinking.

VIII. MESOGONISTIUS.

1864. **Mesogonistius** Gill, Amer. Journ. Sci. and Arts, 92 (*chætodon*).

Type: *Pomotis chætodon* Baird.

Etymology: Μέσος, middle; γωνία, angle; ἱστίον, sail.

ANALYSIS OF THE SPECIES OF MESOGONISTIUS.

a. Body suborbicular, compressed; head moderate; snout shorter than eye; mouth very small; maxillary reaching to pupil; eye large, 3 to $3\frac{1}{4}$ in head; opercular spot much smaller than eye, with a crescent-shaped pale center; scales large; dorsal spines elevated, longest reaching just beyond eye; pectorals and ventrals reaching anal, ventral spine reaching anus. Clouded straw-color sides with 6 to 8 conspicuous black irregular vertical bars, first through the eye, second in front of pectorals, interrupted on the operculum, third at the front of the dorsal covering the membrane of the first three spines, and forming a median black stripe on each ventral fin, the fourth at front of soft dorsal, fifth opposite its last ray, last at base of caudal; fins mottled; head, 3 to $3\frac{1}{5}$; depth, $1\frac{3}{5}$ to $1\frac{4}{5}$; D. x, 10; A. III, 12; lat. l., 28; L., 3 inches .... CHÆTODON, 11.

11. MESOGONISTIUS CHÆTODON.

(Plate LXX, fig. 2.)

Pomotis chætodon Baird, Ninth Smith. Rept., 324 1854 (Cedar Swamp Cr., N. J.).
Mesogonistius chætodon Gill, Amer. Journ. Sci. and Arts, 92, 1864.

Habitat: New Jersey to Maryland, only in sluggish streams near the coast.

Etymology: *Chætodon*, a genus of fishes, from χαίτη, hair; ὀδών, tooth.

IX. LEPOMIS.

1819. **Lepomis** Rafinesque, Journ. de Phys., 402 (*auritus*).
1819. **Pomotis** Rafinesque, Journ. de Phys., (*auritus*).
1819. **Apomotis** Rafinesque, Journ. de Phys., 420 (*cyanellus*).
1820. **Icthelis** Rafinesque, Ich. Oh., 27 (*auritus*).
1820. **Telipomis** Rafinesque, Ich. Oh., 27 (*macrochira=pallidus*).
1831. **Bryttus** Cuv. & Val., Hist. Nat. Poiss., 461 (*punctatus*).
1876. **Helioperca** Jordan, Ann. N. Y. Lyc. Nat. Hist., 355 (*pallidus*).

1877. **Xenotis** Jordan, Proc. Acad. Nat. Sci. Phila., 76 (*fallax=megalotis*).
1877. **Xystroplites** Jordan MS., Cope, Proc. Amer. Phil. Soc., 66 (*gillii=albulus*).
1877. **Eupomotis** Gill & Jordan, Field & Forest, 190 (*Sparus aureus=gibbosus*).
1877. **Lepiopomus** Jordan, Ann. N. Y. Lyc. Nat. Hist., 316 (*emend.*).

Type: *Labrus auritus* Linnæus.

Etymology: *λεπίς*, scale; *πῶμα*, opercle.

ANALYSIS OF THE SPECIES OF LEPOMIS.*

a. Lower pharyngeals narrow, teeth conic.

b. Gill-rakers long, stiff; supplementary bone evident, usually well developed; pectorals shorter than head.

c. Scales moderate, lat. l., 43 to 50. (*Apomotis* Rafinesque.)

d. Body oblong, the depth $2\frac{1}{3}$ to $2\frac{1}{2}$ in length; dorsal with a black spot at base of soft rays more or less distinct; head large; snout projecting, $3\frac{1}{2}$ to $3\frac{3}{5}$ in head; mouth large; maxillary reaching middle of eye; eye $4\frac{1}{2}$ to $4\frac{4}{5}$ in head; opercular spot as large as eye, margined, black confined to bony part; scales small; dorsal spines low, longest equal to snout; pectoral short, not reaching anal; ventrals short, not reaching anal fin, spine $1\frac{1}{3}$ to 2 in distance from origin of ventrals to anus. Green, with brassy luster, each scale with a blue spot at base; fins largely blue, anal and ventrals edged with orange; a dark spot at base of last rays of dorsal and usually of anal also; cheeks with blue stripes; iris red. Head, $2\frac{4}{5}$ to 3; depth, $2\frac{1}{3}$ to $2\frac{1}{2}$; D. X, 11; A. III, 9; lat. l., 48 to 50. L., 7 inches........CYANELLUS, 12.

dd. Body short and deep, the depth half the length; dorsal without a black spot at base of soft rays; head rather large; snout moderate; mouth moderate; maxillary reaching to posterior border of pupil; eye large, shorter than snout, $4\frac{1}{4}$ in head; opercular spot as large as eye, margined above and below; scales large, 6 to 7 rows on cheeks; dorsal elevated, longest spine as long as from tip of snout to middle of pupil; pectorals reaching anal; ventral spines $1\frac{1}{2}$ in distance from origin of ventrals to anus, fin not reaching anal. General color olive-green; unmarked. Head, 3; depth, 2 to $2\frac{1}{5}$; D. X, 10; A. III, 9; lat. l., 43 to 46. L., 6 inches........................ISCHYRUS, 13.

cc. Scales rather large, 33 to 34 in lateral line. Body short and deep, robust; dorsal and ventral curves equal; head moderate; snout very short, $4\frac{1}{2}$ to 5 in head; mouth small; maxillary extending to posterior border of pupil; eye large, $3\frac{1}{4}$ to $3\frac{1}{2}$ in head; opercular spot smaller than eye, higher than long, margined with black on the bony part; scales large; dorsal spines moderately high, longest spine reaching posterior border of eye; pectorals shorter than head, not reaching anal; ventrals not reaching anal, spine long, $1\frac{1}{4}$ to $1\frac{1}{3}$ in distance between origin of ventrals and anus. Dark green, sides with about 10 vertical bars; dorsal in ♀ with a black ocellus on last ray; cheeks not striped. Head, $2\frac{4}{5}$ to 3; depth, 2 to $2\frac{1}{5}$; lat. line, 33 to 34. L., $2\frac{1}{2}$ inches.......................SYMMETRICUS, 14.

*Some of the characters used in this key are variable, and with young specimens it must be used with caution.

bb. Gill-rakers moderate or shortish; supplementary maxillary very small or obsolete. (*Lepomis.*)

e. Pectorals moderate or short, shorter than head; usually no distinct black spot on last rays of dorsal or anal.

f. Mucous pores large; opercular spot wholly surrounded by a very broad red margin; scales very large, lat. l., 33 to 35. Body oblong, moderately compressed; head rather large; snout moderate, $3\frac{1}{2}$ in head; mouth moderate; maxillary reaching nearly to middle of pupil; eye rather large, $3\frac{1}{2}$ to 4 in head; mucous pores large, those on preopercle especially so; opercular spots rather long, as large as or larger than eye, the black not confined to the bony part; dorsal rather high, longest spine as long as from tip of snout to posterior border of eye; pectorals short, about $1\frac{1}{4}$ in head; ventrals reaching anal, spine $1\frac{1}{2}$ to $1\frac{3}{4}$ in distance between origin of ventrals and anus. Olive, with greenish spots posteriorly; sides with round orange spots; belly and lower fins red. Head, $2\frac{3}{4}$; depth, $2\frac{1}{4}$ to $2\frac{3}{4}$; lat. line, 32 to 35. L., $2\frac{1}{2}$ inches...... HUMILIS, 15.

ff. Mucous pores small; opercular spot various; scales moderate or small, 35 to 43.

g. Pectoral fin rather long and slender, reaching to first soft rays of anal, and as long as head without flap; dorsal spines high, the longest as long as snout and eye; general form and coloration of *Lepomis humilis*, the scales smaller and the fins longer; body oblong, compressed; profile depressed above eye, the snout projecting; mouth moderate, the lower jaw projecting, the maxillary reaching to below front of pupil; opercular flap moderate, with a wide red margin; ventrals reaching anal; gill-rakers shortish and thick; scales 6–40 to 43–13, 5 or 6 on cheek; eye moderate, $3\frac{3}{4}$ in head, a little longer than snout. Color light olive; back and sides mottled with olive, these markings taking the form of chain-like crossbands; adult with round orange spots on sides, as in *L. humilis*; fins plain.......................... MACROCHIRUS, 16.

gg. Pectoral fins short, not reaching beyond front of anal, and shorter than head without opercular flap; dorsal spines low, not longer than from snout to posterior margin of pupil.

h. Opercular flap in the adult very long, longer than high, and usually with a red margin, which is generally narrow.

i. Palatine teeth none; gill-rakers very short and weak; body deep, with the back rounded. Color of adult, brilliant orange and blue, the former color predominating below, the blue in wavy streaks, the orange in spots; head with conspicuous blue stripes; fins mostly with the membranes orange, the rays blue. Body short and deep, compressed; profile steep; head short; snout short, 4 to $4\frac{1}{2}$ in head; maxillary extending to opposite middle of pupil; eye moderate, $3\frac{1}{2}$ to 4 in head; opercular spot usually larger than eye, and margined with red, in the adult becoming very long and rather broad; scales moderately small; dorsal spines rather low, longest reaching from snout to posterior border of pupil; pectorals shorter than head; ventrals not reaching anal, spine, $1\frac{1}{4}$ to $1\frac{1}{2}$ in distance from origin of ventrals to anus. Head, 3; depth, $2\frac{1}{4}$ to $2\frac{1}{2}$; lat. line, 35 to 42. L., 6 in....... MEGALOTIS, 17.

ii. Palatine teeth present, few; gill-rakers moderate; body oblong; adult olive; belly and lower fins largely red; scales on sides with bluish spots; bluish stripes on head, especially before eye. Body elongate, moderately deep, profile steep; head moderately long; snout short, 4 in head; maxillary extending to posterior border of pupil; opercular flap becoming very long in the adult, but always remaining narrow; eye moderate, 4 in head; scales varying in size: dorsal spines low, longest reaching to pupil; pectorals reaching to anal; ventrals usually not reaching anal; spine $1\frac{1}{2}$ to $1\frac{3}{4}$ in distance from origin of ventrals to anus. Head, $2\frac{3}{4}$ to 3; depth, $2\frac{1}{8}$ to $2\frac{1}{4}$; lat. line, 38 to 48. L., 8 inches ....AURITUS, 18.

hh. Opercular spot higher than long; cheeks without distinct blue stripes, sides of body with round orange spots; body deep and compressed.

j. Body without conspicuous brown spots, dusky, fins darker; scales above lat. l. with rows of dark spots, as in *auritus;* below lat. l. are about 7 rows of bronze spots, which fade out towards the belly; lower fins dusky; body moderately robust, short and deep, compressed; head small; snout short, smaller than eye; maxillary reaching middle of pupil; eye large, $3\frac{1}{2}$ to $3\frac{3}{4}$ in head; opercular spot margined above and below; scales moderate, five or six rows on cheeks; dorsal moderate, longest spine reaching from tip of snout to posterior border of pupil; pectorals short, $1\frac{1}{4}$ in head, not quite reaching anal; ventrals nearly reaching anal. Head, 3; depth, 2; lat. l., 36 to 38.
GARMANI, 19.

jj. Body covered with conspicuous brown spots, like fly-specks. Olivaceous, with numerous small deep-brown spots, smaller than pinheads; these are most distinct on the lower parts of the side, where they form lines along the rows of scales, and on opercles; body robust, short and deep, compressed; head small; snout short, 4 in head: maxillary extending to middle of pupil; eye large, $3\frac{1}{2}$ in head; opercular spot about as large as eye, black, confined to bony part; scales rather large; dorsal spines rather high, longest reaching posterior border of eye; pectorals short, not reaching anal; ventrals not reaching anal; spine $1\frac{3}{4}$ in distance from origin of ventrals to anus. Head, 3; depth, $1\frac{7}{8}$ to 2; lat. line, 40 to 45; L., 5 inches ....PUNCTATUS, 20.

ee. Pectorals longer than head; dorsal and anal with a black spot at base of posterior ray. Body short and deep, compressed; head small; snout short, 4 in head; maxillary reaching front of pupil; eye large, $3\frac{1}{2}$ to $3\frac{3}{4}$ in head; opercular flap usually higher than long and the black confined, but in some southern specimens longer than high and with a black membranaceous border, with or without a pale margin below; scales moderate; dorsal spines high, longest reaching posterior border of eye; pectorals reaching middle of anal; ventrals not reaching anal; spine $1\frac{3}{4}$. Olive green; young, purplish silvery, with crossbars; belly coppery red in old specimens. Head, 3; depth, 2; lat. line, 42 to 44; L., 10 inches ....PALLIDUS, 20.

aa. Lower pharyngeals broader, teeth bluntly conic or paved. (*Xystroplites* Jordan.)

k. Cheeks without wavy blue lines; dorsal not mottled; sides of body not spotted.

l. [Pectorals shorter than head, not extending beyond ventrals; body elongate, rather deep mesially; caudal peduncle rather elongate; snout projecting, forming an angle above eye; mouth wide, the lower jaw projecting; maxillary reaching just past front of pupil; eye as long as opercular flap, 4½ in head; flap moderate, broad, with a very wide pale margin below and behind; dorsal spines moderate, as long as snout and half of orbit; five rows of scales on cheeks; lower pharyngeals blunt, almost paved; light olive, uniform in spirits; traces of dusky mottlings on last rays of dorsal and anal. Head, 2⅘; depth 2; lat. l., 42; L., 5 inches] (Jordan & Gilbert.) ALBULUS, 22.

ll. Pectorals longer than head, extending past ventrals.

m. Scales along lateral line 34 to 39; dorsal and ventral outlines about equally curved; body moderately elongate, compressed; head rather large; snout 3½ to 4 in head; maxillary slightly longer than snout; eye moderate, 3½ to 4⅓ in head; opercular flap much smaller than eye, black confined, pale margin widest above and below; scales rather large, 4 rows on cheeks; longest dorsal spine reaching past posterior border of pupil; pectorals reaching beyond middle of anal; ventral spine 1½ to 1⅓ in distance between origin of ventrals and anus; dusky olive, silvery beneath. Head, 2⅘ to 3; depth, 2 to 2⅗ .. HEROS, 23.

mm. Scales along lateral line 42 to 44; dorsal outline much more strongly curved than ventral; longest dorsal spine reaching posterior border of eye; scales smaller than in *notatus;* rest as in the above species ... HOLBROOKI, 24.

kk. Cheeks with wavy blue lines; dorsal mottled; sides of body spotted; body short and deep; head small; snout short, 4½ in head; maxillary extending to pupil; eye moderate, 4 to 4¼ in head; opercular spot about equal to eye, margined below and behind, black not confined; scales rather large; dorsal spines moderately low, longest reaching middle of pupil; pectorals scarcely longer than head; ventrals not reaching anal, spine 1¼ to 1½ in distance between origin of ventrals and anus. Greenish-olive, sides bluish, belly and lower fins orange; the sides profusely mottled with orange; dorsal bluish, orange-spotted. Head, 3 to 3½; depth, 2 to 2¼; lat. line, 38 to 48; L., 8 inches.................................GIBBOSUS, 25.

12. LEPOMIS CYANELLUS.

(Green Sunfish; Little Red-eye.)

Lepomis cyanellus Rafinesque, Journ. de Phys., 420, 1819.
Icthelis cyanella Rafinesque, Ich.Oh., 28, 1820 (Ohio River).
Chænobryttus cyanellus Jordan, Man. Vert., ed. 1, 234, 1876.
Telipomis cyanellus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Apomotis cyanellus Jordan, Ann. N. Y. Lyc. Nat. Hist., 376, 1877 (White River).

Icthelis melanops Rafinesque, Ich. Oh., 28, 1820 (Ohio River.)
Chænobryttus melanops Gill, Amer. Jour. Sci. and Arts, 91, 1864.
Lepomis melanops Cope, Jour. Acad. Nat. Sci. Phila. 1868, 223.
Chænobryttus cyanellus melanops Jordan, Man. Vert., ed. 1, 234, 1876.
Pomotis longulus Baird and Girard, Proc. Ac. Nat. Sci. Phila. 1853, 391 (Platte R.; Otter Cr., Ark.; Rios Ciloco, Seco, and Pecos, Texas; Mineville, Texas).
Bryttus longulus Baird and Girard, Proc. Acad. Nat. Sci. Phila. 1854, 25.
Calliurus longulus Girard, U. S. Pac. R. R. Surv., 16, 1859.
Calliurus diaphanus Girard, Proc. Acad. Nat. Sci. Phila. 1857 (Rio Blanco, Tex.).
Telipomis diaphanus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Calliurus microps Girard, Proc. Acad. Nat. Sci. Phila. 1857 (Rio Brazos, Tex.; Fort Washita).
Lepomis microps Cope, Journ. Acad. Nat. Sci. Phila. 1868, 222.
Telipomis microps Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Calliurus murinus Girard, Proc. Acad. Nat. Sci. Phila. 1857 (Rio Brazos, Delaware Creek, Tex.).
Bryttus murinus Gunther, Cat. Fish. Brit. Mus., 1, 260, 1859.
Telipomis murinus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Lepomis murinus McKay, Proc. U. S. Nat. Mus. 1881, 88.
Calliurus formosus Girard, Proc. Acad. Nat. Sci. Phila. 1857 (Brazos and Colorado Rivers, Gypsum Creek, Tex.; Fort Smith, Ark.).
Bryttus signifer Girard, Proc. Acad. Nat. Sci. Phila. 1857 (Rio Medina, Texas).
Ichthelis signifer Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Bryttus mineopas Cope, Proc. Acad. Nat. Sci. Phila. 1865, 84 (Lake Whittlesey, Minn.).
Lepomis mineopas Cope, Jour. Acad. Nat. Sci. Phila., 223, 1868 (Kanawha, Miami, and Missouri Rivers).
Chænobryttus mineopas Cope, 1865.

Habitat: United States, west of the Alleghany Mountains, from the Great Lakes to Georgia, Kansas, and the Rio Grande River.

Etymology: *Κύανος*, dark blue.

The synonomy of *cyanellus* as given above agrees with that given by McKay and others, except that I have included *Calliurus murinus* Girard as a full synonym.

13. LEPOMIS ISCHYRUS.

Lepiopomus ischyrus Jordan and Nelson, Bull. U. S. Nat. Mus. x, 25, 1877 (Illinois River).
Apomotis phenax Cope & Jordan, Bull. U. S. Nat. Mus., x, 26, 1877 (Beaseley's Point, N. J.).
Lepomis phenax McKay, Proc. U. S. Nat. Mus. 1881, 88.

Habitat: Streams of Illinois.

Etymology: *'Ισχυρός*, robust.

I have examined the types of *Apomotis phenax* and of *Lepomis ischyrus* and have come to the conclusion that the two are identical. They agree closely in technical characters, differing only in features which may be due to size or to the condition of the specimens.

The description in the analysis is drawn from the types of *phenax*. The following notes are taken from the type of *Lepomis ischyrus* Jordan & Nelson, kindly sent to me by Dr. S. A. Forbes:

Scales 7-46-15, 6 rows on cheek; longest dorsal spine as long as from tip of snout to anterior margin of pupil; head, 3 in length; depth, 2; pectoral reaching just to anal; ventrals to anal; third anal spine 1⅔ in head; mouth large, the maxillary reaching posterior border of pupil; eye slightly shorter than snout; 4 in head; supplemental maxillary evident as in *Lepomis cyanellus*: gill-rakers large, x, 10; opercular flap larger than eye, the dark spot bordered all around by paler; nape steep, forming an angle with the profile of the head; body short and deep, compressed, heavy forward; no distinct dark spot on dorsal; scales bluish at base, those above lateral line marked as in *Lepomis auritus*.

In the original description the color is said to be "dusky, mottled with orange and blue; cheeks with wide obscure blue bands; a faint, dusky spot on dorsal and anal behind; belly and lower fins coppery yellow; lower jaw and lower parts of head leaden blue."

The type of *Apomotis phenax* is labeled as from "Beaseley's Point, New Jersey," in the museum of the Academy of Philadelphia. This is probably an error. The waters about Beaseley's Point are mostly brackish, and if *phenax* and *ischyrus* be identical the species belongs to the Illinois River basin. This species thus far is the least common of all the sunfishes, and more specimens are greatly desired.

14. LEPOMIS SYMMETRICUS.

Lepomis symmetricus Forbes, in Jordan & Gilbert's Syn. Fish. N. A., 473, 1883 (Illinois River).

Habitat: Lowlands of the Mississippi Valley from central Illinois southward to New Orleans.

Etymology: Latin; symmetrical.

This little species has been found common about New Orleans, and is doubtless widely diffused in the Lower Mississippi.

15. LEPOMIS HUMILIS.

Bryttus humilis Girard, Proc. Acad. Nat. Sci. Phila. 1857 (Sugar Loaf Creek, Ark.; Cottonwood Creek, Utah; Brazos River, Tex.).

Ichthelis humilis Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.

Lepiopomus humilis Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.

Lepomis humilis Cope, Journ. Acad. Nat. Sci. Phila. 1868, 223.

Bryttus oculatus Cope, Proc. Acad. Nat. Sci. Phila. 1865, 83 (Lake Whittlesey, Minn.).

Ichthelis oculatus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.

Lepomus oculatus Cope, Journ. Acad. Nat. Sci. Phila. 1868, 221.

Lepiopomus oculatus Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.

Lepomis anagallinus Cope, Journ. Acad. Nat. Sci. Phila. 1868, 221 (Leavenworth, Kans.).

Ichthelis anagallinus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.

Lepiopomus anagallinus Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.

Habitat: Mississippi Valley from Minnesota to Ohio, to Kansas, and Texas.

Etymology: Latin; humble.

16. LEPOMIS MACROCHIRUS.

Lepomis macrochira Rafinesque, Journ. de Phys., 420, 1819 (Ohio River, Licking River, etc.).
Icthelis macrochira Rafinesque, Ich. Oh., 27, 1820.
Lepiopomus macrochirus Jordan, Ann. Lyc. Nat. Hist., 386, 1877.
Lepomis macrochirus Jordan & Gilbert, Syn. Fish. N. A., 475, 1883.
Lepomis nephelus Cope, Journ. Amer. Phil. Soc., 222, 1868 (Kiskiminitas River, Western Pennsylvania).

Habitat: Ohio Valley; western Pennsylvania to Kentucky and Illinois.

Etymology: *Μακρός*, long; *χείρ*, hand.

This species is rather scarce and has doubtless been confounded with *Lepomis humilis*, which it must resemble in form and color. *L. macrochirus* has, however, smaller scales and much longer pectorals than *L. humilis*, its pectorals being scarcely shorter than in *L. pallidus*. The specimens here described were collected by Mr. A. J. Woolman at Tradewater River, Dawson Springs, Kentucky. This stream is a tributary of the Ohio.

17. LEPOMIS MEGALOTIS.

(Long-eared Sunfish. Plate LXX, fig. 3.)

Icthelis megalotis Rafinesque, Ich. Oh., 29, 1820 (Ohio River).
Xenotis megalotis Jordan, Ann. N. Y. Lyc. Nat. Hist., 373, 1877 (Rock Castle River, Kentucky).
Icthelis aurita Rafinesque, Ich. Oh., 29, 1820 (Ohio River, not *Labrus auritus* L.).
Lepomis auritus Cope, Journ. Acad. Nat. Sci. Phila., 1868, 220.
Ichthelis auritus Jordan, Geol. Rept. Ind., 215, 1875.
Pomotis nitida Kirtland, Bost. Journ. Nat. Hist., 472, 1842 (Ohio).
Ichthelis nitida Jordan, Geol. Rept. Ind., 215, 1875.
Pomotis aquilensis Baird and Girard, Proc. Acad. Nat. Sci. Phila. 1853, 307.
Ichthelis aquilensis Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Xenotis aquilensis Jordan, Bull. x, U. S. Nat. Mus., 36, 1877.
Pomotis breviceps Baird & Girard, Proc. Acad. Nat. Sci. Phila. 1853, 309.
Ichthelis breviceps Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Xenotis breviceps Jordan, Bull. x, U. S. Nat. Mus., 36, 1877.
Pomotis fallax Baird & Girard, Proc. Acad. Nat. Sci. Phila. 1854, 24.
Ichthelis fallax Jordan, Man. Vert., ed. 1, 238, 1876.
Xenotis fallax Jordan, Bull. x, U. S. Nat. Mus., 36, 1877.
Pomotis convexifrons Baird & Girard, Proc. Acad. Nat. Sci. Phila. 1854, 24.
Pomotis nefastus Baird & Girard, Proc. Acad. Nat. Sci. Phila. 1854, 24.
Pomotis sanguinolentus Agassiz, Amer. Jour. Sci. and Arts, 302 (Huntsville Ala.).
Ichthelis sanguinolentus Jordan, Man. Vert., ed. 1, 238, 1876.
Xenotis sanguinolentus Jordan, Ann. N. Y. Lyc. Nat. Hist., 318, 1877.
Pomotis inscriptus Agassiz, Amer. Jour. Sci. and Arts, 302, 1854 (Huntsville, Ala.).
Lepomis inscriptus Cope., Journ. Acad. Nat. Sci. Phila., 221, 1868.
Ichthelis inscriptus Jordan, Man. Vert., ed. 1, 238, 1876.
Xenotis inscriptus Jordan, Ann. N. Y. Lyc. Nat. Hist., 318, 1877.
Pomotis bombifrons Agassiz, Amer. Jour. Sci. and Arts, 303, 1854 (Huntsville, Ala.).

Ichthelis bombifrons Jordan, Man. Vert., ed. 1, 237, 1876.
Lepiopomus bombifrons Jordan, Bull. x, U. S. Nat. Mus., 36, 1877.
Lepomis bombifrons Jordan, Man. Vert., ed. 2, 240, 1878.
Lepiopomus bombifrons Jordan, Bull. x, U. S. Nat. Mus., 36, 1877.
Pomotis marginatus Holbrook, Journ. Acad. Nat. Sci. Phila. 1855, 49 (St. John's River, Fla.).
Ichthelis marginatus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Xenotis marginatus Jordan, Bull. x, U. S. Nat. Mus., 36, 1877.
Lepomis marginatus McKay, Proc. U. S. Nat. Mus. 1881, 89.
Pomotis popeii Girard, U. S. Pac. R. R. Surv., x, 26, 1859 (Colorado River).
Xenotis popii Jordan, Bull. x, U. S. Nat. Mus., 36, 1877.
Lepomis peltastes Cope, Proc. Amer. Phil. Soc., 1870, 453.
Ichthelis peltastes Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Xenotis lythochloris Jordan, Ann. N. Y. Lyc. Nat. Hist., 1877, 376 (Wabash R.).
Xenotis aureolus Jordan, Ann. N. Y. Lyc. Nat. Hist., 376 (Wabash River).

Habitat: Great Lake region to Georgia and Mexico west of the Alleghanies.

Etymology: *Μέγας*, great; *ὄυς*, ear.

18. LEPOMIS AURITUS.

(Yellow-belly; Red-breast Bream. Plate LXXI, fig. 1.)

Labrus auritus Linnæus, Syst. Nat., ed. x, 283, 1758 (Philadelphia).
Lepomis auritus Gill, Amer. Journ. Sci. and Arts, 93, 1854.
Ichthelis auritus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Lepiopomus auritus Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.
Bryttus unicolor Cuv. & Val., Hist. Nat. Poiss., 1831, 464 (Philadelphia and Charleston).
Pomotis solis Cuv. & Val., Hist. Nat. Poiss., VII, 468, 1831 (New Orleans).
Ichthelis solis Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Xenotis solis Gill & Jordan, Bull. x, U. S. Nat. Mus., 22, 1877 (Tangipahoa River, Louisiana).
Lepomis auritus solis McKay, Proc. U. S. Nat. Mus. 1881, 89.
Pomotis rubricauda Storer, Bost. Jour. Nat. Hist., 1842, 177 (Massachusetts).
Ichthelis rubricauda Holbrook, Ich. S. C., 15, 1860.
Lepomis rubricauda Cope, Proc. Amer. Phil. Soc., 452, 1870.
Pomotis elongatus Holbrook, Journ. Acad. Nat. Sci. Phila. 1855, 47 (South Carolina and Florida).
Ichthelis elongatus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Lepiopomus elongatus Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.
Lepomis ophthalmicus Cope, Journ. Acad. Nat. Sci. Phila. 1868, 233 (Roanoke R.).
Xenotis ophthalmicus Jordan, Bull. x, U. S. Nat. Mus., 36, 1877.
Lepomis mystacalis Cope, Proc. Amer. Phil. Soc., 66, 1877.
Lepiopomus mystacalis Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.
Lepiopomus miniatus Jordan, Bull. x, U. S. Nat. Mus., 26, 1877 (Tangipahoa R., La.).
Lepomis miniatus McKay, Proc. U. S. Nat. Mus. 1881, 89.
Not syn.—*Pomotis auritus* Günther, Cat. Fish. Brit. Mus., I, 261 (Lake Erie, New Orleans; = *gibbosus*).

Habitat: Maine to Texas, east of the Alleghany Mountains.

Etymology: Latin; long-eared.

I now refer *elongatus*, *mystacalis*, and *miniatus* to the synonymy of *auritus*.

Pomotis elongatus Holbrook agrees in all respects with *auritus*, with the exception of a "dark blotch on the tail behind dorsal fin," but as this is a character which does not occur in any known sunfish, it is safe to say that it is based on erroneous observations. There is in the museum at Cambridge, Massachusetts, a sunfish labeled "*Lepomis elongatus* Holbrook and Agassiz," from South Carolina, which is identical with *auritus*. Although probably not a type specimen of *elongatus*, nevertheless it affords a clew as to the identity of Holbrook's species.

The *Lepomis mystacalis* Cope agrees with *auritus* in the number of scales in the lateral line and partly in color, and with *holbrooki* in the number of scales on cheeks and the silvery coloration. But it is no doubt identical with *auritus*, for the next species Cope described after *mystacalis* is *Xystroplites gillii*, which is identical with *holbrooki* as is shown by the character of the pharyngeal teeth. The teeth of *mystacalis* he does not describe and the natural inference is that they must have been of the *auritus* type. *Lepomis miniatus** Jordan I am unable to satisfactorily separate from *auritus*, although the specimens examined differ somewhat in coloration, and none of them are as large as the adult *auritus*.

19. LEPOMIS GARMANI.

Lepomis garmani Forbes, Bull. Ill. State Lab. Nat. Hist., 135, 1885 (Wabash and Little Fox Rivers).

Habitat: Wabash and Illinois valleys.

Etymology: Named after Dr. Harrison Garman, of Champaign, Ill.

20. LEPOMIS PUNCTATUS.

(Chinquapin Perch. Plate LXXI, fig. 2.)

Bryttus punctatus Cuv. & Val., Hist. Nat. Poiss., VII, 462, 1831 (Charleston).
Ichthelis punctatus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Lepomis punctatus Jordan, Proc. U. S. Nat. Mus. 1879, 224.
Bryttus reticulatus Cuv. & Val., Hist. Nat. Poiss., VII, 463, 1831 (Charleston).
Lepomis apiatus Cope, Proc. Amer. Phil. Soc., 1877, 65 (Volusia, Fla.).
Lepiopomus apiatus Jordan, Bull. X, U. S. Nat. Mus., 25, 1877 (St. John's River).

Habitat: South Carolina to Florida, in lowland streams.

Etymology: Latin; dotted.

21. LEPOMIS PALLIDUS.

(Blue-gill; Dollar Dee; Blue Bream; Copper Nose. Plate LXXI, fig. 3.)

Labrus palladus Mitchill, Trans. Lit. & Phil. Soc. N. Y. 1815, 407 (New York).
Pomotis pallidus Agassiz, Amer. Jour. Sci. and Arts, 303, 1854 (Huntsville, Ala.).
Eupomotis pallidus Gill & Jordan, Bull. X, U. S. Nat. Mus., 21, 1877.
Lepiopomus pallidus Gill & Jordan, Ann. N. Y. Lyc. Nat. Hist., 316, 1877.
Helioperca pallida Jordan, Ann. N. Y. Lyc. Nat. Hist., 355, 1877.
Lepomis pallidus Jordan, Man. Vert., ed. 2, 241, 1878.

* This species needs further comparison before it is definitely united to *Lepomis auritus*. It is also a question as to whether a subspecies *solis* can be maintained for the southern form of *Lepomis auritus* (Carolina to Louisiana).—JORDAN.

Lepomis appendix Mitchill, Amer. Mont. Mag., 247, 1818.
Ichthelis appendix Jordan, Man. Vert., ed. 1, 239, 1876.
Pomotis gibbosus Cuv. & Val., Hist. Nat. Poiss., VII, 467, 1831 (Charleston).
Pomotis macrochira Kirtland, Bost. Journ. Nat. Hist. 1842, 469 (not of Rafinesque).
Pomotis incisor Cuv. & Val., VII, 468, 1831 (New Orleans).
Ichthelis incisor Holbrook, Ich. S. C., 12, 1855.
Lepomis incisor Gill, Amer. Jour. Sci. and Arts, 93, 1864.
Pomotis speciosus Baird & Girard, Proc. Acad. Nat. Sci. Phila. 1854, 24.
Ichthelis speciosus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Ichthelis incisor speciosus Jordan, Man. Vert., ed. 1, 236, 1876.
Pomotis obscurus Agassiz, Amer. Journ. Sci. and Arts, 303 (Huntsville, Ala.).
Ichthelis obscurus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Lepiopomus obscurus Jordan, Ann. N. Y. Lyc. Nat. Hist., 317, 1877.
Lepomis obscurus Jordan, Man. Vert., ed. 2, 242, 1878.
Ichthelis incisor obscurus Jordan, Man. Vert., ed. 1, 236, 1876.
Pomotis luna Girard, Proc. Acad. Nat. Sci. Phila., 1857.
Lepomis longispinis Cope, Proc. Acad. Nat. Sci. Phila. 1865, 83 (Leavenworth, Kansas).
Lepomis ardesiacus Cope, Journ. Phila. Nat. Sci. 1868, 222 (Kiskiminitas River).
Lepomis purpurescens Cope, Proc. Amer. Phil. Soc. 1870, 453 (Yadkin River).

Habitat: Eastern United States on both sides of the Alleghanies from the Great Lakes, New York to Florida, Virginia, Kansas, and Texas.

Etymology: Latin; pale.

The synonymy of *Lepomis pallidus* has been carefully worked out by Jordan & McKay, and I see no reason to dissent from their conclusion.

22. LEPOMIS ALBULUS.

Bryttus albulus Girard, Proc. Acad. Nat. Sci., Phila., 1857 (Rio Blancos).
Ichthelis albulus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Apomotis albulus Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.
Lepomis albulus Cope, Journ. Acad. Nat. Sci. Phila., 223, 1881.
Xystroplites gillii Jordan, Bull. x, U. S. Nat. Mus., 24, 1877, "Garden Key, Fla." (Probably an error.)

Habitat: Georgia to Texas.

Etymology: Latin; whitish.

The habitat assigned *Xystroplites gillii* is doubtless erroneous, as there is no fresh-water stream or pond on the island of Garden Key.

23. LEPOMIS HEROS.

Pomotis heros Baird & Girard, Proc. Acad. Nat. Sci. Phila. 1854, 25 (Rio Cibolo, Rio Nueces, Rio Blanco, Dry Creek, Texas; Fort Bliss, New Mexico; Rio San Juan).
Xystroplites heros Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.
Lepomis heros McKay, Proc. U. S. Nat. Mus. 1881, 89.
Pomotis notatus Agassiz, Amer. Journ. Sci. and Arts, 302, 1854 (Huntsville, Ala.).
Ichthelis notatus Jordan, Indiana Geol. Rept., 215, 1876.
Xystroplites notatus Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.
Lepomis notatus McKay, Proc. U. S. Nat. Mus. 1881, 92.
Lepomis holbrooki notatus Jordan, Man. Vert., ed. 5, 119, 1888.

Habitat: Southern Indiana to Florida and Texas, in lowland streams.

A careful comparison of the figures and descriptions of *heros* with two specimens of *notatus* from Posey County, Indiana, shows that the two species are probably identical. The type of *heros* is an old example. I have no means of positively deciding which of the two names, *heros* and *notatus*, has priority of date.

24. LEPOMIS HOLBROOKI.

Pomotis holbrooki Cuv. & Val., Hist. Nat. Poiss., VII, 466, 1831 (Charleston, S. C.).
Eupomotis holbrooki Jordan, Proc. U. S. Nat. Mus. 1879, 224.
Lepomis holbrooki McKay, Proc. U. S. Nat. Mus. 1881, 92.
Pomotis speciosus Holbrook, Journ. Acad. Nat. Sci. Phila. 1850, 48 (St. John's R.).
Eupomotis speciosus Jordan, Bull. x, U. S. Nat. Mus., 35, 1877.
Pomotis microlophus Günther, Cat. Fish. Brit. Mus., I, 264, 1859.
Ichthelis microlophus Jordan & Copeland, Bull. Buff. Soc. Nat. Hist., 138, 1876.
Xystroplites longimanus Cope, Proc. Amer. Phil. Soc. 1877, 66 (Volusia and Bay Port, Fla.).

Habitat: Virginia to Florida, in streams of the lowlands.

Etymology: To John Edwards Holbrook, author of Ichthyology of South Carolina.

25. LEPOMIS GIBBOSUS.

(Common Sunfish; Pond Fish; Pumpkin Seed; Sunny. Plate LXXII, fig. 1.)

Perca gibbosus Linnæus, Syst. Nat., ed. x, 292, 1758 (after *Perca fluviatilis gibbosa, ventre luteo*, of Catesby).
Lepomis gibbosus McKay, Proc. U. S. Nat. Mus., 91, 1881.
Sparus aureus Walbaum, Artedi, Pisc., 290, 1792 (lakes of New York).
Eupomotis aureus Jordan, Bull. x., U. S. Nat. Mus., 35, 1877.
Morone maculata Mitchill, Fishes N. Y., 18, 1814.
Pomotis vulgaris Cuv. & Val., Hist. Nat. Poiss., III, 91, 1829.
Pomotus raveneli Cuv. & Val., Hist. Nat. Poiss., VII, 465, 1831 (Philadelphia).
Pomotis catesbei Cuv. & Val., Hist. Nat. Poiss., VII, 469, 1831 (Philadelphia.)
Pomotis solis Cuv. & Val., Hist. Nat. Poiss., VII, 468, 1831 (Philadelphia, New Orleans; in part).
Lepomis euryorus McKay, Proc. U. S. Nat. Mus. 1881, 89 (Fort Gratiot, Lake Huron).

Habitat: Great Lake region and Upper Mississippi Valley, eastward to Maine, and thence south to Florida, east of the mountains, not descending south of the Upper Wabash and Upper Illinois in the west.

Etymology: Latin; gibbous.

Of the four species of *Lepomis* (*cyanellus*, *megalotis*, *pallidus*, and *gibbosus*) that are found in the lakes of Michigan, Mr. McKay's *euryorus* seems to agree best with the last, as is shown by the character of the pharyngeal teeth, gill rakers, and the opercular flap. It is probably based on a very old example of *Lepomis gibbosus*.

X. MICROPTERUS.

1802. **Micropterus** Lacépède, Hist. Nat. Poiss., IV, 325 (*dolomieu*).
1810. **Calliurus** Rafinesque, Journ. de Phys., 420 (*punctulatus=dolomieu*).
1820. **Aplites** Rafinesque, Ich. Oh., 30 (*pallidus=salmoides*).
1820. **Lepomis** Rafinesque, Ich. Oh., 30 (not *Lepomis* Raf., 1819; *pallida = salmoides*).
1820. **Nemocampsis** Rafinesque, Ich. Oh., 31 (*flexuolaris=dolomieu*).
1820. **Dioplites** Rafinesque, Ich. Oh., 32 (*salmonea=dolomieu*).
1828. **Huro** Cuv. & Val., Hist. Nat. Poiss., II, 124 (*nigricans=salmoides*).
1829. **Grystes** Cuv. & Val., Hist. Nat. Poiss., III, 54 (*salmoides*).

Type: *Micropterus dolomieu* Lacépède.

Etymology: *Μικρός*, small; *πτερόν*, fin.

ANALYSIS OF THE SPECIES OF MICROPTERUS.

a. Mouth moderate, the maxillary in adult not extending beyond eye; scales small, about 11–74–17; young more or less barred or spotted, never with a lateral band...DOLOMIEU, 25.

aa. Mouth very large, the maxillary in the adult extending beyond the eye; scales rather large, about 7–68–16; last spine of dorsal short, so that the fin is almost divided in two; young with a blackish lateral band...........SALMOIDES, 26.

26. MICROPTERUS DOLOMIEU.

(Small-mouthed Black Bass. Plate LXXII, fig. 2.)

Micropterus dolomieu Lacépède, Hist. Nat. Poiss., IV, 325, 1802.
Bodianus achigan Rafinesque, Amer. Mont. Mag. 120, 1817 (New York, Canada).
Lepomis achigan Gill, Proc. Acad. Nat. Sci. Phila. 1860, 20.
Micropterus achigan Gill, Rept. Com. Agri., 407, 1866.
Calliurus punctulatus Rafinesque, Ich. Oh., 26, 1820 (Falls of the Ohio).
Lepomis trifasciata Rafinesque, Ich. Oh., 31 (Ohio, etc.).
Lepomis flexuolaris Rafinesque, Ich. Oh., 31 (Ohio).
Lepomis salmonea Rafinesque, Ich. Oh., 32 (Kentucky, Green, Licking, Ohio Rivers).
Lepomis notata Rafinesque, Ich. Oh., 32.
Etheostoma calliura Rafinesque, Ich. Oh., 36 (Ohio, Salt River).
Cichla variabilis Le Sueur, MS. in Museum d'Hist. Nat., Paris, 1822.
Dioplites variabilis Vail. & Boc., MS. Miss. Sci. Mex., 1874.
Micropterus variabilis Vail. & Boc., Miss. Sci. Mex. (ined.), 1874.
Cichla fasciata Le Sueur, Journ. Acad. Nat. Sci. Phila., 216 (Lake Erie).
Centrarchus fasciatus Kirtland, Bost. Journ. Nat. Hist., 28, 1842.
Grystes fasciatus Agassiz, Lake Superior, 295, 1850 (Lake Huron).
Micropterus fasciatus Cope, Proc. Acad. Nat. Sci. Phila. 1865, 83.
Cichla ohioensis Le Sueur, Journ. Acad. Nat. Sci. Phila. 1822, 218 (Ohio River).
Cichla minima Le Sueur, Journ. Acad. Nat. Sci. Phila. 1822, 220 (Lake Erie).
Centrarchus obscurus DeKay, Fishes New York, 30, 1842.
Grystes nigricans Garlick, Treat. Art. Prop. Fish, 185, 1857 (St. Lawrence, etc.).

Habitat: Lake Champlain, Manitoba, and southward to Kansas, on both sides of the mountains from James River southward, chiefly in clear lakes and running streams.

Etymology: To M. Dolomieu, a naturalist, of Paris, at the end of the last century. As the synonymy of the two species of *Micropterus* is now well established, I have nothing new to offer concerning them. For a complete account of both species of *Micropterus* see Henshall's excellent "Book of the Black Bass."

27. MICROPTERUS SALMOIDES.

(Large-mouthed Black Bass. Plate LXXII, fig. 3.)

Labrus salmoides Lacépède, Hist. Nat. Poiss., 716, 1802.
Grystes salmoides Agassiz, Lake Superior, 295, 1850.
Dioplites salmoides Vail. & Boc., MS. Miss. Sci. Mex., 1874.
Micropterus salmoides Vail. & Boc., Miss. Sci. Mex. (ined.), 1874.
Lepomis pallida Rafinesque, Ich. Oh., 30, 1820 (Ohio, Miami, Hockhocking Rivers).
Micropterus pallidus Jordan, Ann. N. Y. Lyc. Nat. Hist., 314, 1877.
Cichla floridana Le Sueur, Journ. Acad. Nat. Sci. Phila. 1822, 219 (E. Florida).
Micropterus floridanus Goode, Bull. VI, U. S. Nat. Mus., 63, 1876.
Huro nigricans Cuv. & Val., Hist. Nat. Poiss., 124, 1828 (Lake Huron).
Grystes nigricans Agassiz, Lake Superior, 297, 1850 (Great Lakes).
Micropterus nigricans Cope, Proc. Acad. Nat. Sci., Phila. 1865, 83.
Grystes nobilis Agassiz, Amer. Journ. Sci. and Arts, 1854, 298 (Huntsville, Ala.).
Grystes nuecensis Baird & Girard, Proc. Acad. Nat. Sci. Phila., 25 (Rio Frio and Rio Nueces, Texas).
Dioplites nuecensis Girard, U. S. Pac. R. R. Surv. 4, 1859 (Rio Cibolo, Rio Blanco).
Micropterus nuecensis Vail. & Boc., MS. Miss. Sci. Mex., 1874.
Grystes megastoma Garlick, Treat. Art. Prop. Fish, 108, 1857.
Dioplites treculii Vail. & Boc., MS. Miss. Sci. Mex., 1874.

Habitat: Lake Champlain to Manitoba, and southward to Virginia, Florida, and Mexico; chiefly in lakes and lowland streams.

Etymology: *Salmo*, salmon; εἶδος, like.

SUMMARY.

Family **CENTRARCHIDÆ.**

Subfamily **CENTRARCHINÆ.**

I. Centrarchus Cuvier & Valenciennes.

1. *Centrarchus macropterus* (Lacépède).

II. Pomoxis Rafinesque.

2. *Pomoxis sparoides* (Lacépède).
3. *Pomoxis annularis* Rafinesque.

Subfamily **LEPOMINÆ.**

III. Archoplites Gill.

4. *Archoplites interruptus* (Girard).

IV. Ambloplites Rafinesque.

5. *Ambloplites rupestris* (Rafinesque).

V. Chænobryttus Gill.

6. *Chœnobryttus gulosus* (Cuv. & Val.).

VI. Acantharchus Gill.

7. *Acantharchus pomotis* (Baird).

VII. Enneacanthus Gill.

8. *Enneacanthus obesus* (Baird).
9. *Enneacanthus gloriosus* (Holbrook).
10. *Enneacanthus eriarchus* (Jordan). (Doubtful species).

VIII. Mesogonistius Gill.

11. *Mesogonistius chætodon* (Baird).

IX. Lepomis Rafinesque.

§ *Apomotis* Rafinesque.

12. *Lepomis cyanellus* Rafinesque.
13. *Lepomis ischyrus* Jordan & Nelson.
14. *Lepomis symmetricus* Forbes.

§ *Lepomis.*

15. *Lepomis humilis* (Girard).
16. *Lepomis macrochirus* Rafinesque.
17. *Lepomis megalotis* (Rafinesque).
18. *Lepomis auritus* (L.).
19. *Lepomis garmani* Forbes.
20. *Lepomis punctatus* (Cuvier & Valenciennes).
21. *Lepomis pallidus* (Mitchill).

§ *Xystroplites* Jordan.

22. *Lepomis albulus* (Girard).
23. *Lepomis heros* (Baird & Girard).
24. *Lepomis holbrooki* (Cuv. & Val.).
25. *Lepomis gibbosus* (L.).

Subfamily **MICROPTERINÆ.**

X. Micropterus Lacépède.

26. *Micropterus dolomieu* Lacépède.
27. *Micropterus salmoides* Lacépède,

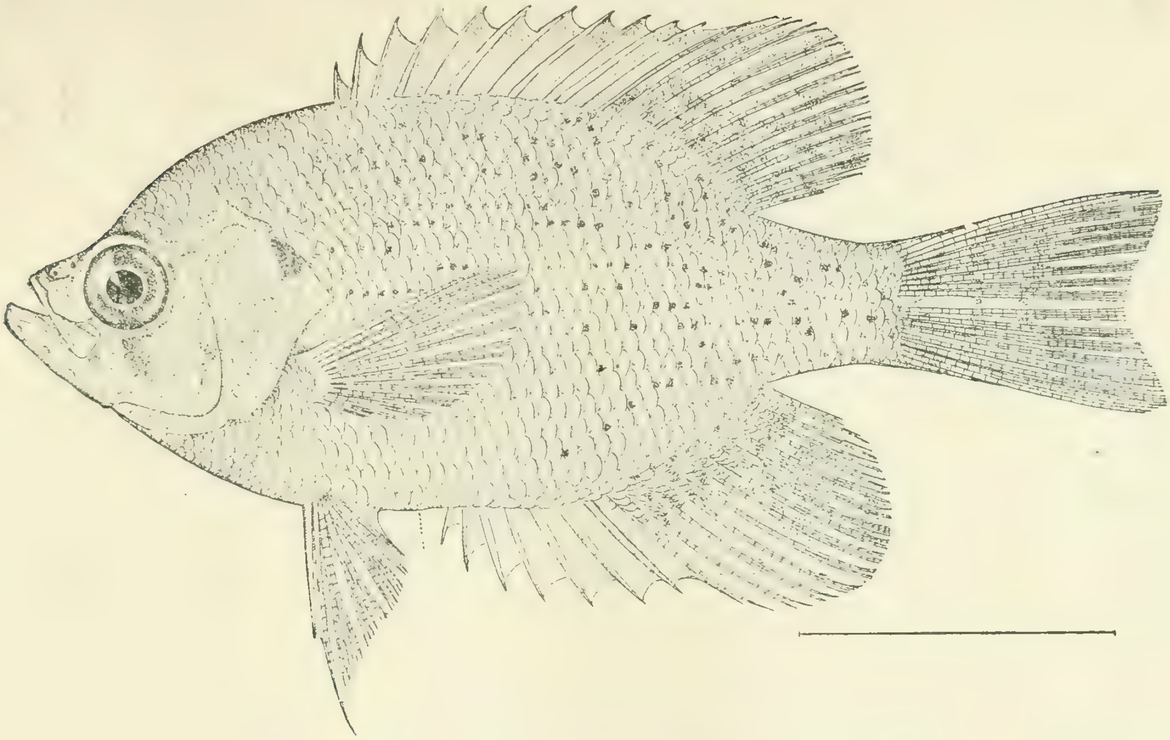


FIG. 1. CENTRARCHUS MACROPTERUS. Round Sunfish.

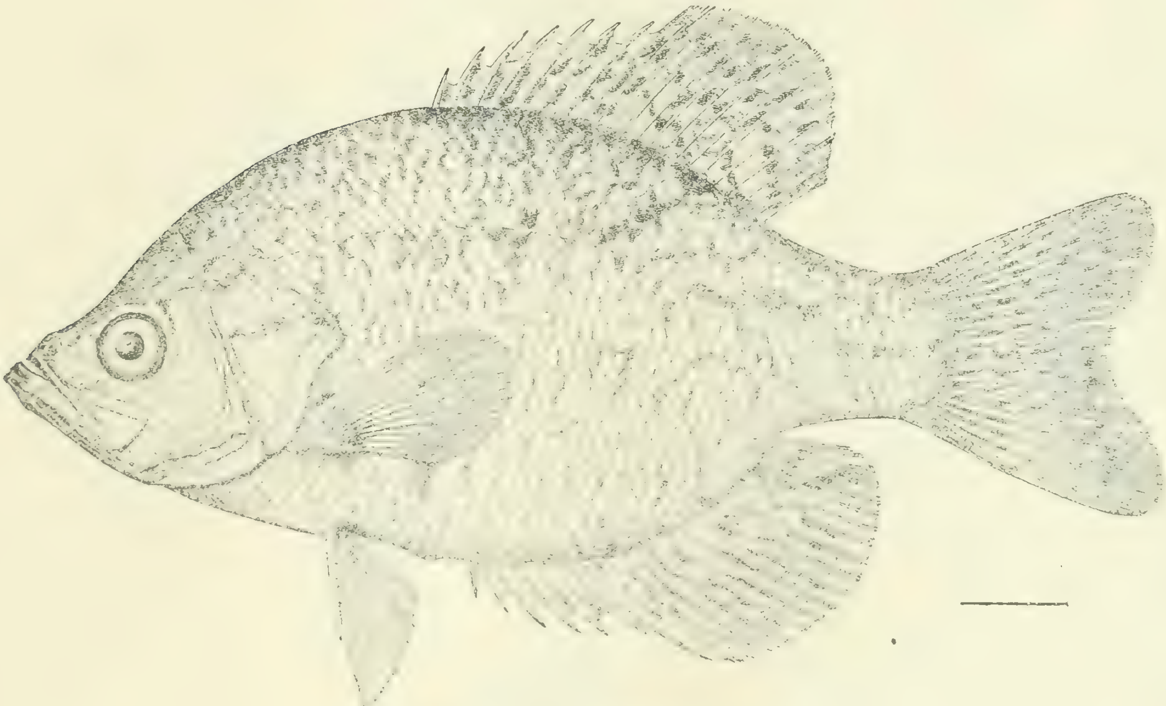


FIG. 2. POMOXIS SPAROIDES. Calico Bass; Grass Bass; Tin-mouth.

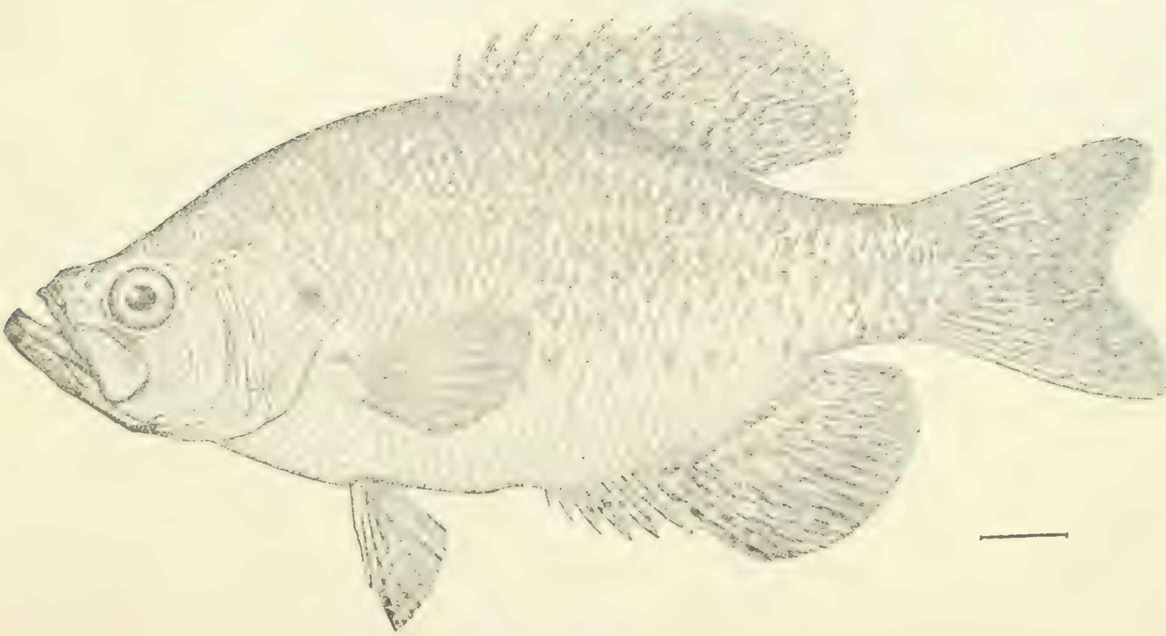


FIG. 3. POMOXIS ANNULARIS. Crappie; New Light.

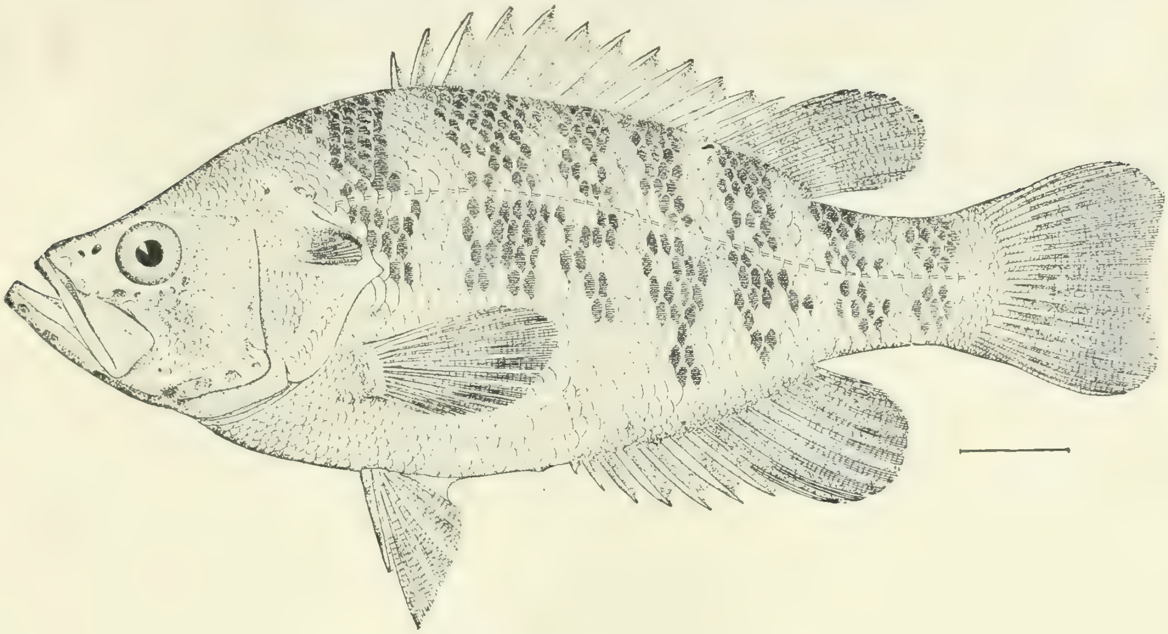


FIG. 1. ARCHOPLITES INTERRUPTUS. Sacramento Perch.

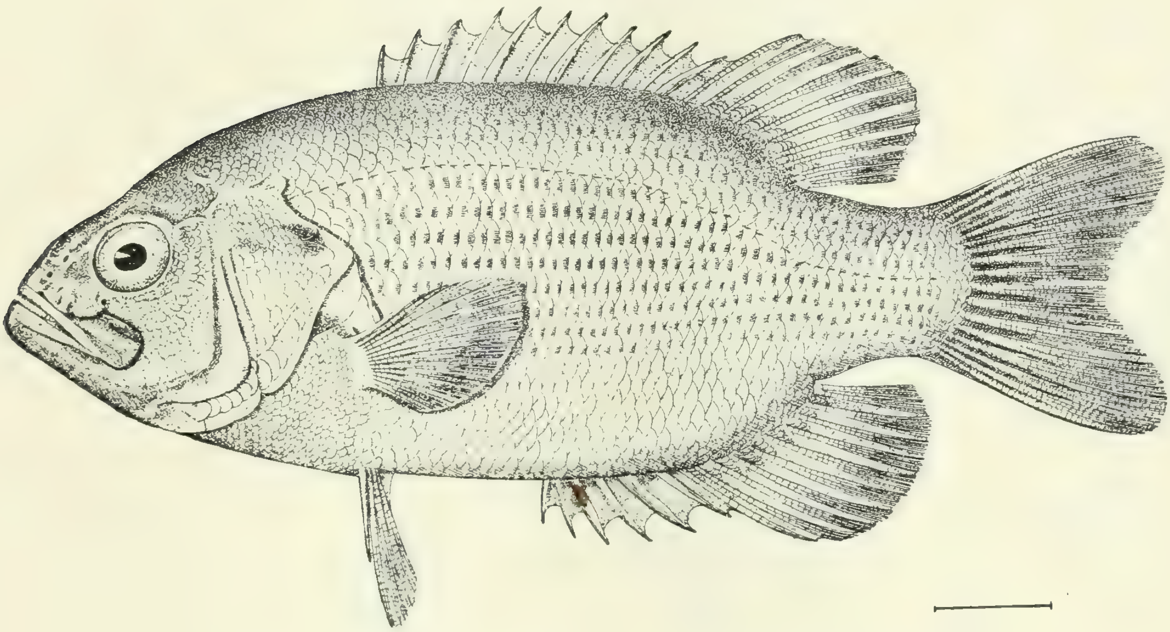


FIG. 2. AMBLOPLITES RUPESTRIS. Red-eye; Goggle-eye; Rock Bass.

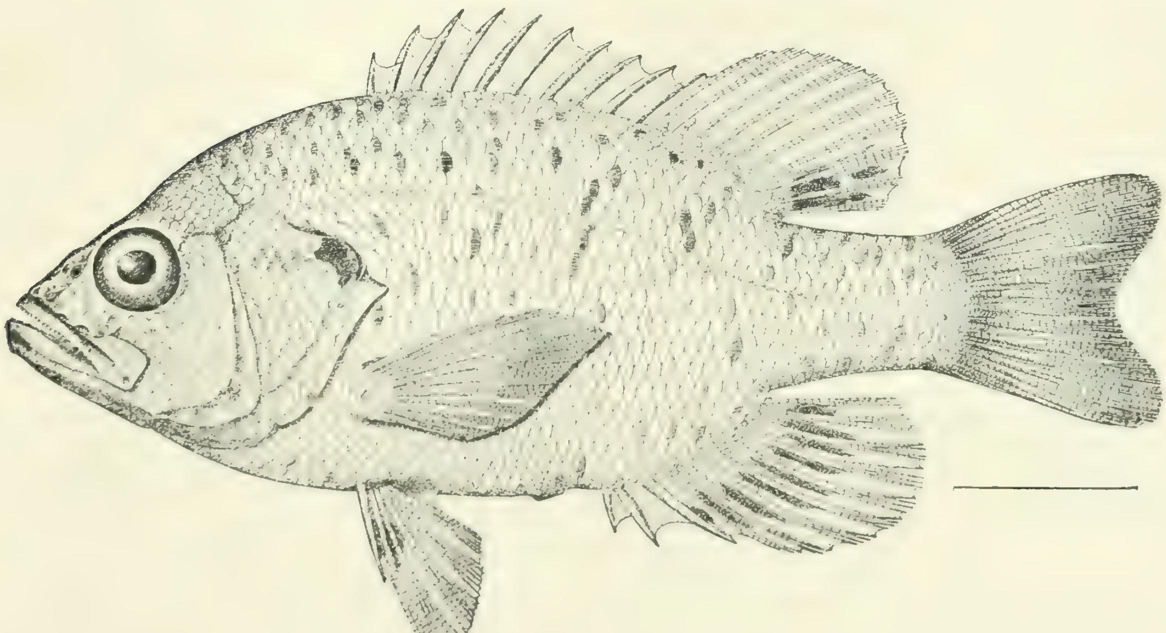


FIG. 3. CHÆNOBRYTTUS GULOSUS. War-mouth.

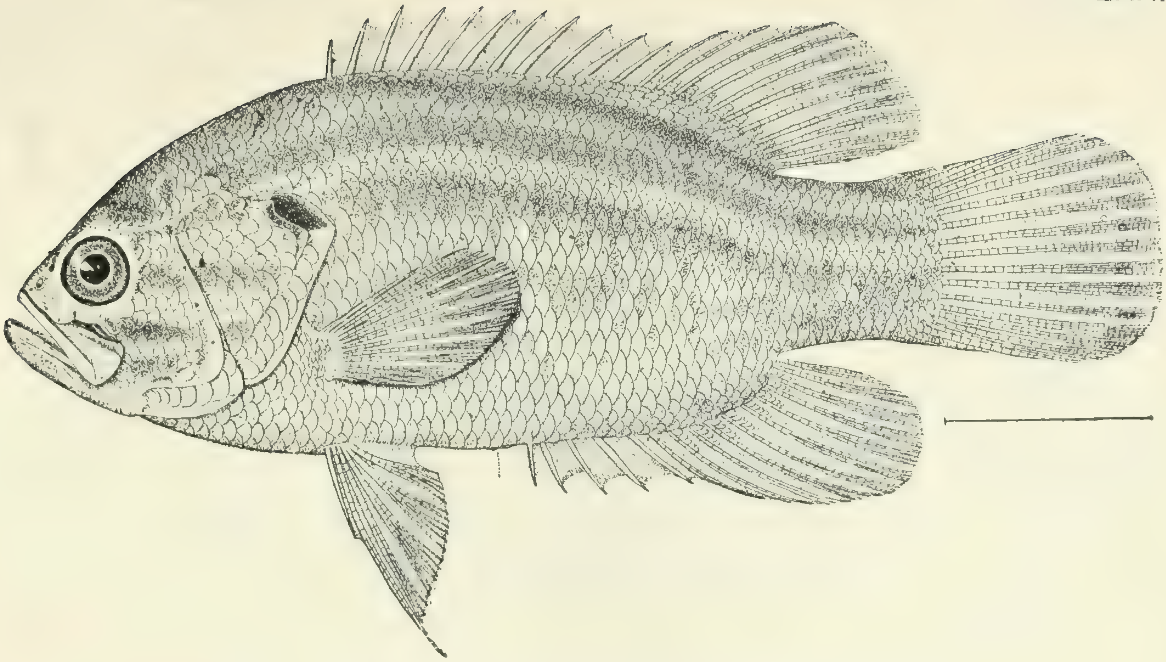


FIG. 1. ACANTHARCHUS POMOTIS. Mud Bass; Mud Sunfish.

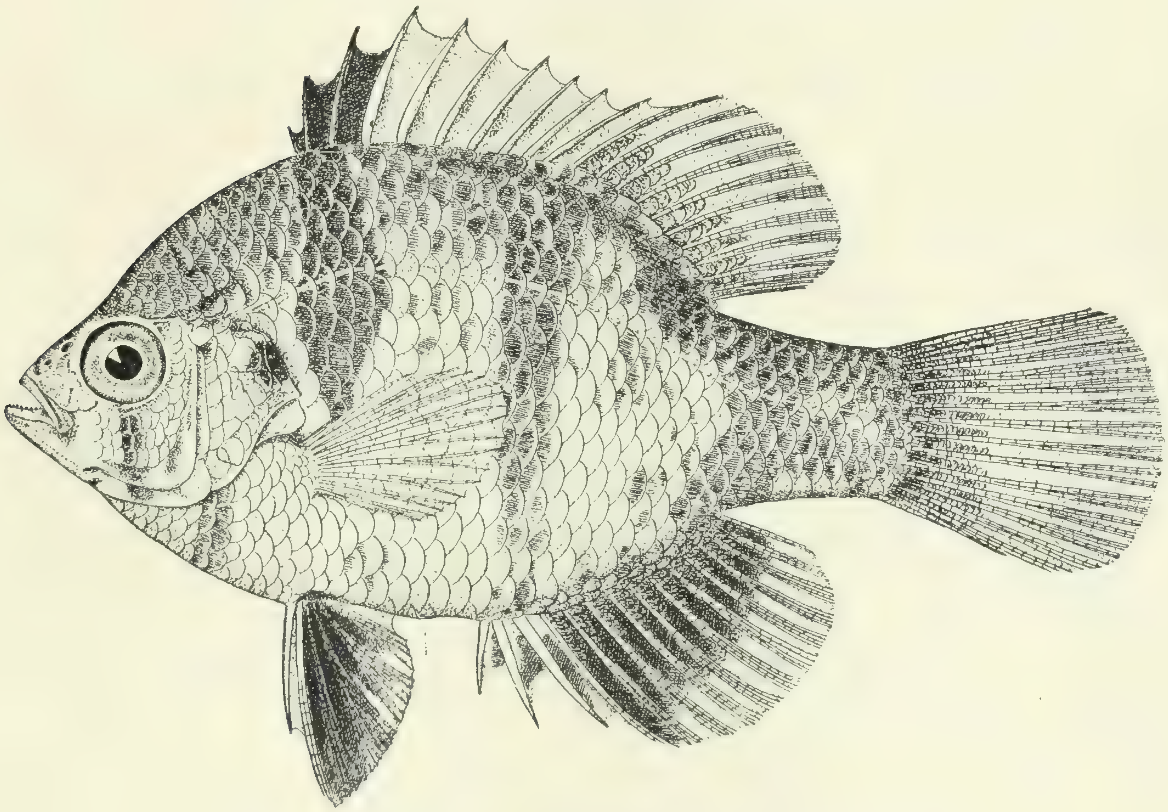
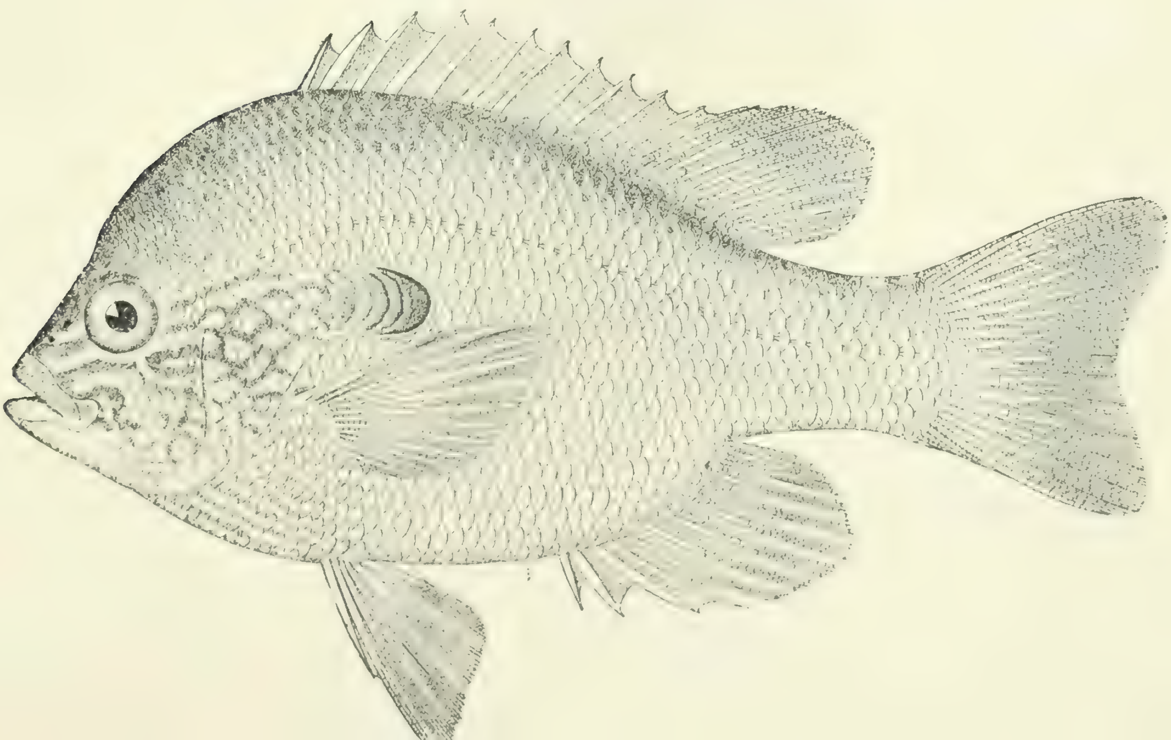


FIG. 2. MESOGONISTIUS CHÆTODON. Black-banded Sunfish.



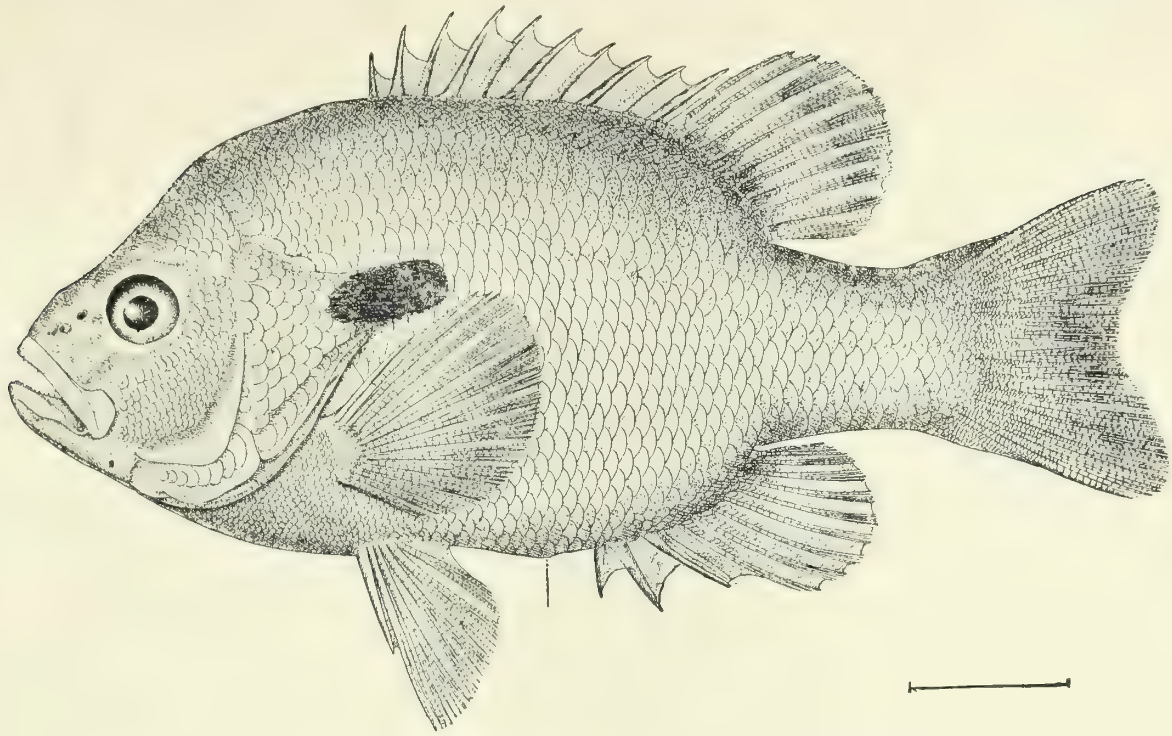


FIG. 1. LEPOMIS AURITUS. Yellow-belly; Red-breasted Bream.

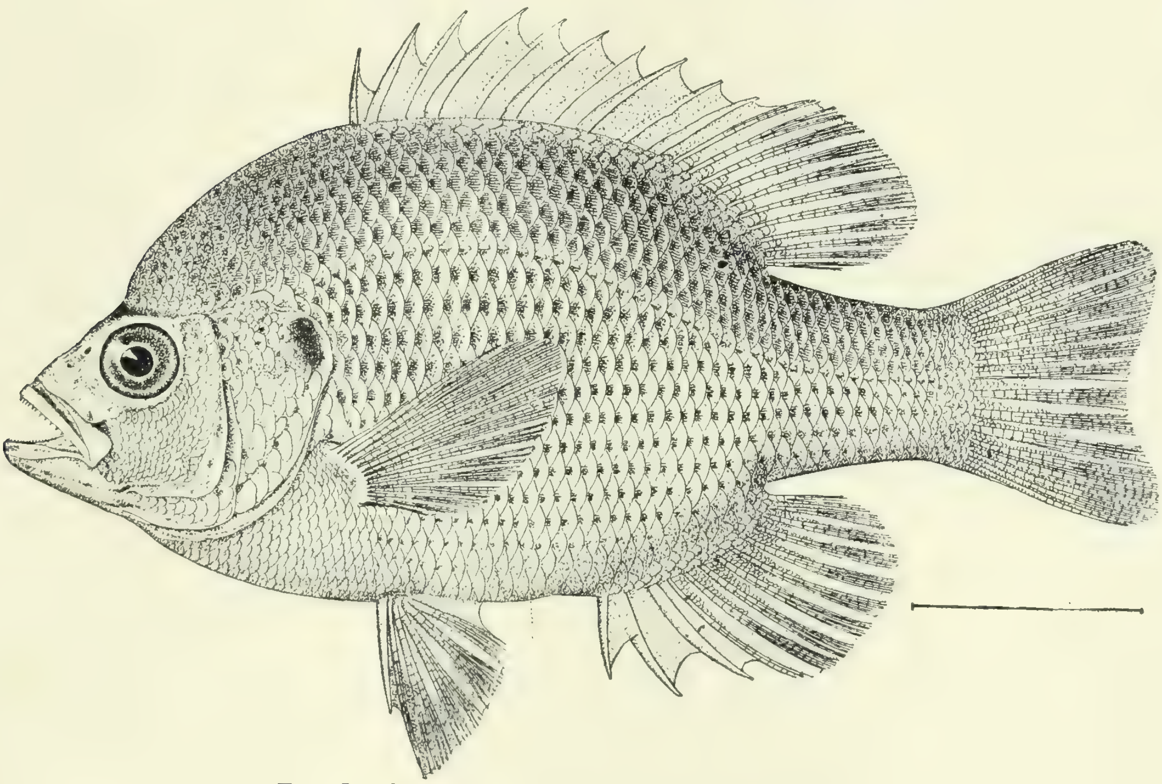
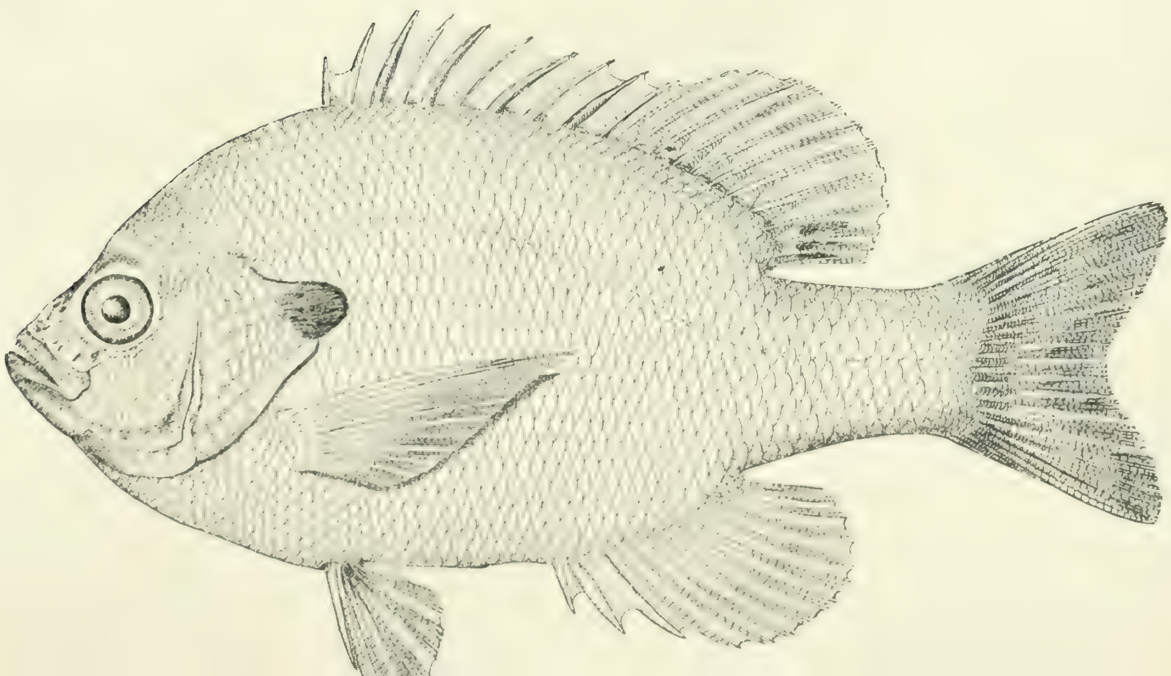


FIG. 2. LEPOMIS PUNCTATUS. Chinquapin Perch.



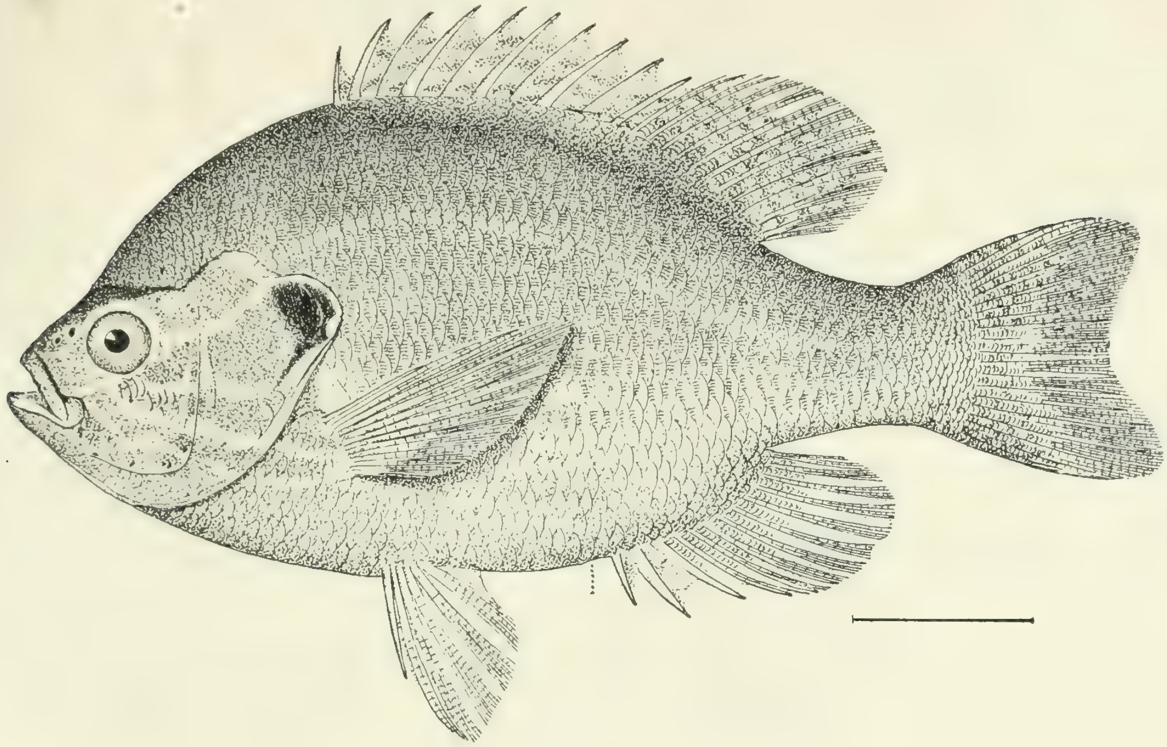


FIG. 1. LEPOMIS GIBBOSUS. Pumpkin Seed; Sunny.

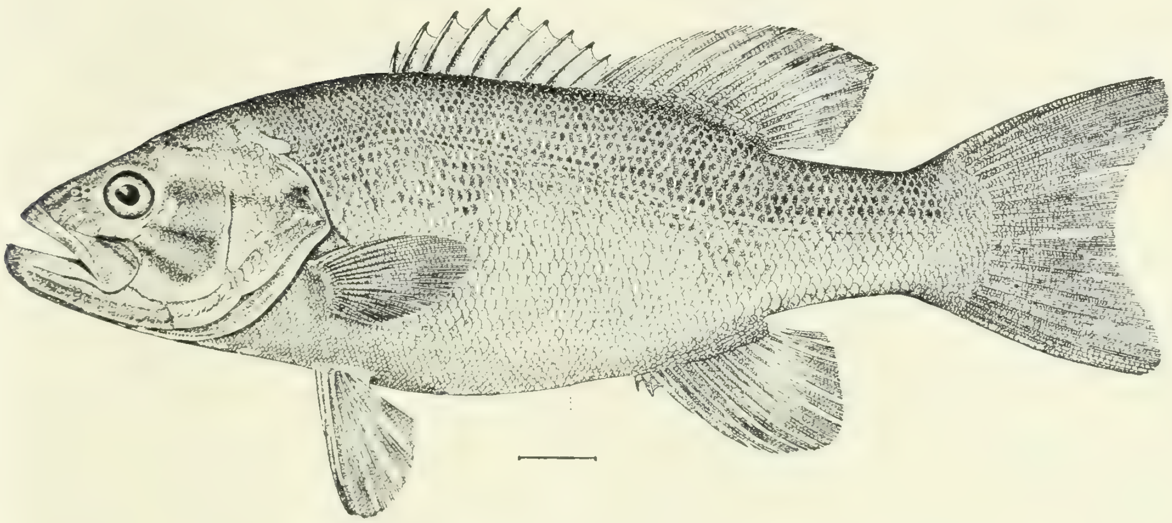


FIG. 2. MICROPTERUS DOLOMIEU. The Small-mouth Black Bass.
(Collected at Little Falls, Potomac River, by Maj. T. J. Hobbs.)

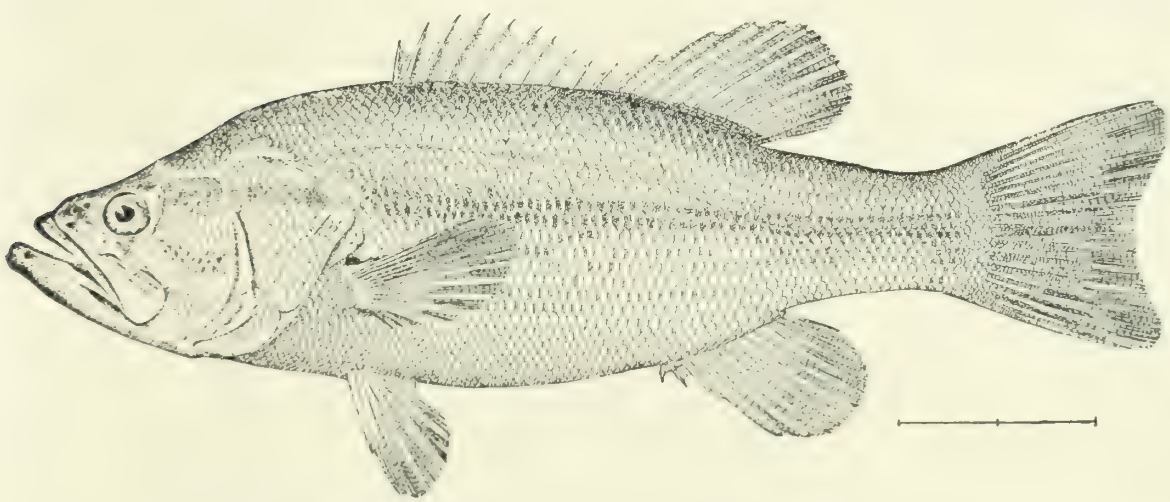


FIG. 3. MICROPTERUS SALMOIDES. The Big-mouth Black Bass.
(Collected at Sandusky, Ohio, by J. W. Milner.)

9.—A PRELIMINARY REVIEW OF THE APODAL FISHES OR EELS INHABITING THE WATERS OF AMERICA AND EUROPE.

By David Starr Jordan and Bradley Moore Davis.

In the present paper is given the synonymy of fishes of the order of Apodes, commonly known as Eels, Morays, or Congers, which are known to inhabit the North Atlantic and the waters of America and Europe.

Few groups of fishes are less thoroughly known than the eels. They are not so easily obtained by collectors as fishes of most other types, and they have been less satisfactorily studied. Many of the species currently recognized are doubtful or based on insufficient or imperfect material.

The division into families is still a provisional one, for the osteology of only a few of the genera has been critically examined. It is hoped that the present paper may help in some degree to fix our knowledge and to prevent further confusion.

The work of making a critical review of the eels was begun in 1888 by the late Charles Harvey Bollman. Much of the synonymy of the species was collected by him, and several analytical keys to the species were prepared. His manuscript has been entirely rewritten by the present authors, who wish however to express their acknowledgment of the help received from it. We are also largely indebted to Dr. Charles H. Gilbert, who has placed the *Albatross* collections at our disposal and has freely given us the use of his unpublished descriptions and determinations.

This paper is based on the collections in the Museum of the University of Indiana and on material collected for the U. S. Fish Commission by the steamer *Albatross*. Most of the specimens in the U. S. National Museum have also been examined by us. Of the 128 species here recognized, 53 have not been studied by us.

We accept the order of Apodes as limited by Dr. Gill, including in it the *Enchelycephali* and *Colocephali* of Professor Cope. Of eel-shaped fishes we exclude the *Gymnotidæ* (*Glanencheli*), *Monopteridæ* (*Ichthyocephali*), *Symbranchidæ* (*Holostomi*), and *Saccopharyngidæ* (*Lyomeri*), which form each a separate order or suborder of Physostomous fishes, and among which we should probably look for the ancestry of the Apodes.

The order of *Apodes* has been succinctly defined by Dr. Gill (Century Dictionary, p. 262) in the following words:

Teleost fishes with the intermaxillaries atrophied or lost, the supermaxillaries lateral, and the body anguilliform and destitute of ventral fins.

The most striking feature is the absence of the premaxillaries, taken in connection with the elongate form and the little development of the scapular arch, which is not attached to the cranium. Other characters not confined to the Apodes are the following: The absence of the symplectic bone, the reduction of the opercular apparatus and of the palatopterygoid arch, the absence of ventral fins, and the reduction or total absence of the scales. There are no spines in the fins, the gill-openings are comparatively small, and there are no pseudobranchiæ. The vertebræ are in large number, as is shown in the following table:

Numbers of vertebræ in Apodes.

Murænesox coniceps	40+ 71=111	Gymnothorax unicolor†	65+ 71=136
Anguilla anguilla	46+ 70=116	Muræna helena †	70+ 71=141
Echidna catenata †	65+ 51=116	Ophichthus gomesi	45+ 96=141
Gymnothorax meleagris †	60+ 60=120	Gymnothorax ocellatus	48+ 94=142
Gymnothorax nebulosus †	65+ 57=122	Gymnothorax moringa †	65+ 79=144
Gymnothorax undulatus †	64+ 68=132	Synaphobranchus pinnatus†	31+115=146
Ophichthus ocellatus	52+ 82=134	Leptocephalus conger	55+ 99=154
Echidna zebra †	97+ 38=135	Gordiichthys irretitus	125+100=225

The *Apodes* are naturally divisible into two series or suborders, typified respectively by the Eels and Morays. These groups have been called *Enchelycephali* and *Colocephali* by Cope. The American and European Morays belong to a single family, *Murænidæ*, but the proper subdivision of the true Eels is very unsettled. In the present paper we have recognized twelve families among the American genera, but until their skeletons are fully studied, the position and value of some of these groups is problematical. If any subdivisions are made among the Congroid Eels, we see no alternative but to recognize the chief groups as distinct families.

To those who prefer not to give such rank to groups like *Ophisuridæ*, *Echelidæ*, etc., the following arrangement might be found acceptable:

COLOCEPHALI.
- *Murænidæ.*

ENCHELYCEPHALI.
- *Congridæ.*
  - Ophisurinæ.
  - Echelinæ.
  - Stilbiscinæ.
  - Murænesocinæ.
  - Nettastominæ.
  - Nemichthyinæ.
  - Heterocongrinæ.
  - Congrinæ.
- *Anguillidæ.*
  - Anguillinæ.
  - Simenchelyinæ.
  - Ilyophidinæ.
  - Synaphobranchinæ.

---

† According to Günther.

But the mutual relations and value of these groups can only be ascertained by a thorough study of the anatomy of the various genera, and until such studies are made these groups may stand as separate families. As Cope has observed, there is no more propriety in putting all Eels in one family because of their agreement in form than there would be in putting in a similar family all fishes which agree in being "fish-shaped."

The following analytical key gives the salient characters of the families included in the present paper:

ANALYSIS OF THE FAMILIES OF APODES FOUND IN EUROPE AND AMERICA.

A. Opercular bones present and at least one osseous branchial arch; pharyngeal jaws developed; ceratohyal present. (**Apodes.**)

a. * Gill-openings small, roundish, leading to restricted interbranchial slits; tongue wanting; pectoral fins (typically) wanting; opercles feebly developed; fourth gill-arch modified, strengthened and supporting pharyngeal jaws. (Suborder COLOCEPHALI.)

b. Scapular arch obsolete or represented by cartilage; heart not far back; pectorals wanting; (skin thick; coloration often variegated.) MURÆNIDÆ, I.

aa. Gill-openings larger, leading to larger interbranchial slits; tongue present; opercles and branchial bones better developed; scapular arch present. (Suborder ENCHELYCEPHALI.)

c. Scales wholly wanting; eggs (so far as known) of moderate size, much as in ordinary fishes.

d. Tip of tail without rays, projecting beyond the dorsal and anal fins (not filiform); posterior nostril on the edge of the upper lip; anterior nostril near tip of snout, usually in a small tube; tongue usually adnate to the floor of the mouth. (Coloration frequently variegated.) ....OPHISURIDÆ, II.

dd. Tip of tail with a more or less distinct fin, the dorsal and anal fins confluent around it; the tail sometimes ending in a long filament. (Coloration almost always plain, brownish, blackish, or silvery, the fins often black-margined.)

e. Posterior nostril close to the edge of the upper lip; tongue more or less fully adnate to the floor of the mouth; teeth subequal. ECHELIDÆ, III.

ee. Posterior nostril without tube, situated entirely above the upper lip.

f. Tongue narrow, adnate to the floor of the mouth or only the tip slightly free; vomerine teeth well developed, sometimes enlarged.

g. Jaws not attenuate and recurved at tip; gill-openings well separated; anterior nostrils remote from eye.

h. Pectoral fins well developed; skin thick; skeleton firm; snout moderate; tail not ending in a filiform tip. MURÆNESOCIDÆ, IV.

hh. Pectoral fins wholly wanting; snout and jaws much produced, the upper longer; jaws straight; skin thin, the skeleton weak; tail ending in a filiform tip; gill-openings small, subinferior; teeth sharp, subequal, recurved; a long series on the vomer; deep-sea eels, soft in body, black in color. NETTASTOMIDÆ, V.

* This diagnosis is chiefly taken from Gill, Proc. U. S. Nat. Mus., 1890, 166.

gg. Jaws long and slender, tapering to a point, recurved at tip; nostrils large, both pairs close in front of eye; gill-openings convergent forward, separate or confluent; pectorals and vertical fins well developed; membranes of fins thin, not enveloping the rays; skeleton well developed; deep-sea eels.

NEMICHTHYIDÆ, VI.

ff. Tongue broad, largely free anteriorly and on sides; vomerine teeth moderate.

i. Pectoral fins wholly wanting; snout obtuse, very short; body and tail excessively elongate; cleft of mouth oblique, the lower jaw projecting; mouth small; teeth small, sharp, in narrow bands on jaws and vomer; nostrils very small, in front of eye; dorsal beginning just behind gill-opening, the fins rather low; gill-openings lateral.

HETEROCONGRIDÆ, VII.

ii. Pectoral fins well developed; body not excessively elongate; lower jaw not projecting; anterior nostril remote from eye.

CONGRIDÆ, VIII.

cc. Skin covered with rudimentary imbedded scales, usually linear in form, arranged in small groups, and placed obliquely at right angles to those of neighboring groups; pectorals and vertical fins well developed, the latter confluent about the tail; lateral line present; posterior nostril in front of eyes; tongue with its margins free.

i. Gill-openings well separated; branchiostegals long, bent upwards behind.

j. Gill-openings lateral and vertical; snout conic, the jaws not very heavy; gape linear; lips thick; lower jaw projecting; teeth in cardiform bands on jaws and vomer; eggs minute.

ANGUILLIDÆ, IX.

jj. Gill-openings horizontal, inferior.

k. Snout very blunt, with very strong jaws; gape transverse; lips obsolete; teeth blunt, in one series, on jaws only.

SIMENCHELYIDÆ, X.

kk. Snout conical and slender, the jaws of moderate strength; gape lateral; lips suppressed; tongue but little developed; teeth acute, in bands on jaws and vomer...ILYOPHIDÆ, XI.

ii. Gill-openings inferior, very close together, apparently confluent; branchiostegal rays abbreviated behind; head conical; tongue small; posterior nostrils in front of eye.

SYNAPHOBRANCHIDÆ, XII.

Family I.—MURÆNIDÆ.

(MORAYS.)

The *Murænidæ* represent the most degenerate type of eels so far as the skeleton is concerned, and they are doubtless the farthest removed from the more typical fishes from which the eels have descended. The essential characters of the family are thus stated by Dr. Gill:

Colocephalous Apodals with conic head, fully developed opercular apparatus, long and wide ethmoid, posterior maxillines, pauciserial teeth, roundish, lateral branchial apertures, diversiform vertical fins, pectoral fins (typically) suppressed, scaleless skin, restricted interbranchial slits, and very imperfect branchial skeleton, with the fourth branchial arch modified, strengthened, and supporting pharyngeal jaws.

The Morays may be readily distinguished from the other eels by their small round gill-openings and by the absence of pectorals. The body and fins are covered by a thick, leathery skin, the occipital region is elevated through the development of the strong muscles which move the lower jaw, and the jaws are usually narrow and armed with knife-like or else molar teeth.

The Morays inhabit tropical and subtropical waters, being especially abundant in crevices about coral reefs. Many of the species reach a large size, and all are voracious and pugnacious. The coloration is usually strongly marked, the color cells being highly specialized. We exclude from the *Murænidæ* the genus *Myroconger*, from St. Helena, which has pectoral fins, and is probably a type of a distinct family. The remaining species are referable to ten or twelve genera, most of which are found in America.

ANALYSIS OF THE AMERICAN GENERA OF MURÆNIDÆ.

a. Vertical fins rudimentary, confined to the end of the tail (often appreciable only on dissection, or altogether wanting); teeth rather small, pointed, subequal, in several series; posterior nostril round, with a short tube or none.

b. Cleft of the mouth short, not half length of head; snout moderate, about half the gape; tail about as long as trunk .... UROPTERYGIUS, 1.

bb. Cleft of the mouth long, nearly half head; snout very short, less than one-fourth the gape; tail very short, about half rest of body .. CHANNOMURÆNA, 2.

aa. Vertical fins well developed, the dorsal beginning before the vent.

c. Posterior nostril an oblong slit; anterior in a short tube; teeth all pointed; dorsal beginning above the gill-opening; canine teeth strong; tail moderate .... ENCHELYCORE, 3.

cc. Posterior nostril circular, with or without tube; tail moderate, not twice as long as trunk; body not excessively elongate.

d. Teeth all, or nearly all, acute, none of those in the jaws obtuse or molar-like.

e. Anterior nostrils without tube; vomerine teeth in many series; lips with a free fold .... PYTHONICHTHYS, 4.

ee. Anterior nostrils each with a long tube; vomerine teeth in one or two series; lips continuous with skin of head.

f. Posterior nostrils without tube, the margin sometimes slightly raised. GYMNOTHORAX, 5.

ff. Posterior nostrils as well as anterior each in a conspicuous tube. MURÆNA, 6.

dd. Teeth mostly obtuse, molar-like; anterior nostrils only tubular; cleft of mouth rather short; dorsal beginning before the gill-opening. ECHIDNA, 7.

Genus 1.—UROPTERYGIUS.

Gymnomuræna Lacépède, Hist. Nat. Poiss., v, 648, 1803 (*doliata; marmorata*). (Restricted first by Kaup, in 1856, to *doliata*, which is a species of *Echidna*.)

Icthyophis Lesson, Voyage de la Coquille, II, 129, 1830 (*pantherinus=marmoratus*, not of Fitzinger, 1829, a genus of Reptiles.)

Uropterygius Rüppell, Neue Wirbelthiere, Fische, 1838, 83 (*concolor*).

Murænoblenna Kaup, Apodal Fishes, 97, 1856 (*tigrina*), (not of Lacépède, 1803, which is *Myxine*).

Gymnomuræna Bleeker, Günther, etc. (not of Lacépède, as restricted by Kaup).

Type: *Uropterygius concolor* Rüppell.

Etymology: Οὐρά, tail; πτέρυξ, fin.

This genus contains several species of small Morays, distinguished by the apparent absence of fins.

Of the various names applied to this group, only one, *Uropterygius*, is available, for reasons indicated above. Our species (with *U. tigrinus*) differs from the type of the genus *U. concolor* in the presence of a small tube on the anterior nostril. This hardly seems to justify further generic division.

ANALYSIS OF THE AMERICAN SPECIES OF UROPTERYGIUS.

a. Anterior nostril with a short tube; posterior nostril without tube, situated directly over the eye.

b. Body dark brown above; below paler with small dark freckles and pale spots; under side of lower jaw light-colored with brownish and whitish blotches; teeth in jaws biserial, outer teeth small, close together; inner row composed of long depressible canines, not close set; vomerine teeth uniserial; a pore situated just above the posterior nostril; tail rather acute with a very slight dorsal fold, more conspicuous in old specimens, its tip, in young specimens, white; caudal fin obsolete; eye 2 to $2\frac{1}{2}$ in snout; cleft of mouth $2\frac{1}{2}$ to $2\frac{1}{3}$ in head; head $3\frac{1}{3}$ in trunk; tail $\frac{1}{6}$ longer than rest of body......NECTURUS, 1.

1. UROPTERYGIUS NECTURUS.

Gymnomuræna nectura Jordan and Gilbert, Proc. U. S. Nat. Mus., 356, 1882 (Cape San Lucas).

Murænoblenna nectura Jordan, Cat. Fish N. A., 51, 1885.

Habitat: Gulf of California.

Etymology: Νήκτηρ, a swimmer; οὐρά, tail.

This species is not rare in the Gulf of California. Besides the original type, we have examined several specimens obtained from near the entrance to the Gulf by Dr. Gilbert, another (43103, U. S. National Museum) probably also taken at Cape San Lucas by Mr. John Xantus, and a much larger specimen (6349), $10\frac{1}{2}$ inches long, without locality. The large example is much more compressed in form, and it seems to

have a caudal fin, but all probably belong to one species. The specimens taken by Dr. Gilbert (4 to $5\frac{1}{2}$ inches in length) are nearly terete, the tail sharp, and with no appreciable fin. The rays, if any exist, can not be found even on dissection. There is considerable variation in the size of the eye.

Genus 2.—CHANNOMURÆNA.

Channo-Muræna Richardson, Voyage Erebus and Terror, 96, 1844 (*Vittata.*)

Type. *Ichthyophis vittatus* Richardson.

Etymology: Χάννη (from χαίνω, to yawn); Muræna.

This genus is near *Uropterygius*, differing chiefly in the large size of the gape. Two species are known, *C. bennetti*, from Mauritius, and *C. vittata.*

ANALYSIS OF THE AMERICAN SPECIES OF CHANNOMURÆNA.

a. Color pale yellowish-brown with about 15 irregular broad chocolate-colored cross bands, varying in width, sometimes interrupted, sometimes bifurcated, some of them forming complete rings, the pale interspaces usually edged with lighter yellowish; fins wanting; lower jaw projecting; teeth slender, subequal, directed backward; teeth in lower jaw in two series, pointed backwards, the inner teeth the largest, and movable; teeth in upper jaw in three series, the two inner series larger and more or less movable; vomerine teeth in a band, thick-set anteriorly, posteriorly biserial; eye $1\frac{1}{2}$ in snout, situated in the anterior third of gape; snout $4\frac{1}{2}$ in gape; gape 2 in head; head about 4 in trunk, $2\frac{3}{4}$ in tail.. VITTATA, 2.

2. CHANNOMURÆNA VITTATA.

Raro Parra, Dif. Piezas Hist. Nat., 66, lam. 30, fig. 3, 1780 (Havana).

Ichthyophis vittatus Richardson, Voy. Sulph., Fish., 114, pl. 53, figs. 7–9, 1844 (locality uncertain, said to be from China).

Nettastoma or *Channomuræna vittata* Richardson, Voyage Erebus and Terror, Fishes, 96, 1844 (West Indies).

Channomuræna vittata Kaup, Apodes, 97, 1856; Poey, Enumeratio, 160, 1875.

Gymnomuræna vittata Günther, VIII, 134, 1870 (Cuba).

Channomuræna cubensis Poey, Repertorio, II, 266, lam. 3, fig. 6, 1867 (Cuba); Poey, Synopsis, 428, 1868.

Habitat: West Indian fauna.

Etymology: *Vittatus*, striped; but *zonatus* or *fasciatus* would have been more correct.

This singular species is known to us only from a single large specimen (24962, U. S. National Museum), $31\frac{1}{2}$ inches long, sent by Professor Félipe Poey, from Havana. It is said to reach a length of 3 feet. Its peculiar coloration gives it a remarkably snake-like appearance.

Genus 3.—ENCHELYCORE.

?**Enchelynassa** Kaup, Apodes, 72, 1856 (*bleekeri*).

Enchelycore Kaup, l. c. (*euryrhina*).

Type: *Enchelycore euryrhina* Kaup = *Muræna nigricans* Bonnaterre.

Etymology: Ἔγχελυς, eel; κόρη, girl; the application not evident.

This genus contains a single species from the West Indies.

The genus *Enchelynassa* is based on a single specimen from unknown locality. Günther considers it "not improbable that this fish is identical with or closely allied to *Enchelycore*," but the description of Kaup is insufficient for the determination of this point.

ANALYSIS OF THE SPECIES OF ENCHELYCORE.

a. Snout narrow, rather produced, $2\frac{2}{5}$ in gape; the jaws can not be shut in adult examples. Teeth of upper jaw biserial, the inner series of very long and slender depressible canines; long canines not movable in front of each jaw; lateral teeth of lower jaw slender, subequal, sharp, and recurved; vomerine teeth small, uniserial, developed posteriorly; eye moderate, 2 in snout; gape 2 in head; dorsal beginning above the gill opening; tail slightly longer than rest of body; head 3 to $3\frac{1}{4}$ in trunk. Uniform black or dark brown, sometimes faintly marbled with darker; angle of mouth slightly darker; gill-opening pale.
NIGRICANS, 3.

3. ENCHELYCORE NIGRICANS.

Muræna unicolor maxillis elongatis teretiusculis, inferiore longiore, etc., Gronow, Zoophyl., 163, 1763 (South America).
Muræna nigricans Bonnaterre, Encycl. Méth. Ichth., 34, 1788 (after Gronow).
Murænophis nigricans Lacépède, Hist. Nat. Poiss., v, 389, 1803 (after Bonnaterre).
Enchelycore nigricans Günther, VIII, 135, 1870 (Dominica; Grenada; Barbadoes).
Muræna anguina Gronow, Cat. Fish. Brit. Mus., 18, 1854 (rivers of South America).
Enchelycore euryrhina Kaup, Apodes, 73, 1856 (no habitat).
Gymnothorax nigrocastaneus Cope, Trans. Amer. Phil. Soc., 483, 1870 (St. Martin's).
Gymnothorax umbrosus Poey, Ann. Lyc. Nat. Hist. N. Y., 1874, 67 (Havana).

Habitat: Caribbean Sea.

Etymology: Latin, blackish.

This species is not uncommon in the Caribbean Sea. We have examined three specimens in the U. S. National Museum, 6026, collected by Dr. Gill at Barbadoes, 6124, without locality, and 33090, sent from Cuba by Poey. The latter specimen is doubtless the type of *Gymnothorax umbrosus* Poey, which he states has been sent to the Smithsonian Institution.

Cope's *nigrocastaneus* is evidently an *Enchelycore* and agrees with *nigricans* except that the tail is said to be slightly shorter than rest of body.

Genus 4.—PYTHONICHTHYS.

?**Enchelynassa** Kaup, Apodes, 72, 1856 (*bleekeri*).
Pythonichthys Poey, Reportorio Fis. Nat. Cuba, II, 265, 1867 (*sanguineus*).

Type: *Pythonichthys sanguineus* Poey.

Etymology: Πύθων, a large snake; ἰχθύς, fish.

This genus is based on a single West Indian species, which apparently differs from *Gymnothorax* only in the entire absence of nasal tubes. In *Enchelynassa* the posterior nostrils are represented as oval with raised margins. That genus may possibly be identical with *Pythonichthys*, rather than with *Enchelycore*.

ANALYSIS OF THE SPECIES OF PYTHONICHTHYS.

a. [Body terete, slim; the depth contained 40 times in the total length; nostrils in a line between eye and tip of snout, about as long as eye; lips full, each with a fold; dorsal commencing a little before gill-opening; teeth in jaws biserial; those of upper jaw small and numerous, sharp-pointed; outer row of teeth a little larger and less numerous than inner; inner row of teeth in lower jaw granular; teeth on vomer pluriserial, small; eye very small, 6 in snout, 12 in gape; gape 3 in head; head 2 in trunk; tail 2⅗ times rest of body; color, uniform blood-red] (*Poey*).

SANGUINEUS, 4.

4. PYTHONICHTHYS SANGUINEUS.

Pythonichthys sanguineus Poey, Repertorio, II, 265, lam. 2, fig. 7, 1867 (Matanzas, Cuba); Poey, Synopsis, 428, 1868; Poey, Enumeratio, 160, 1875.
Muræna sanguinea Günther, VIII, 126, 1870 (copied).

Habitat: West Indies, Cuba.

Etymology: Latin, blood-colored.

This species, which probably inhabits rather deep water, is known to us only from the accounts given by Poey.

Genus 5.—GYMNOTHORAX.

Gymnothorax Bloch, Ichthyologia, 1795 (*reticularis*).
Thærodontis McClelland, Apodal Fishes of the Ganges, 1843 (*reticulata*).
Lycodontis McClelland, l. c. (*literata*).
Sidera Kaup, Apodes, 70, 1856 (*pfeifferi*).
Eurymyctera Kaup, l. c., 72 (*crudelis*).
Polyuranodon Kaup, l. c., 96 (*kuhli* = *polyuranodon*).
Priodonophis Kaup, Aalenähnliche Fische Hamburg. Museum, 22, 1859 (*ocellatus*).
Neomuræna Girard, U. S. Mex. Bound. Surv., Fishes, 76, 1859 (*nigromarginata* = *ocellatus*).
Pseudomuræna Johnson, Proc. Zool. Soc., 167, 1860 (*madeirensis*).
Tæniophis Kaup, Aale Hamburg. Mus., Nachtrage, 1, 1859 (*westphali* = *funebris*).
Gymnothorax Günther, VIII, 100 (*reticularis*, etc.).
Sidera Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882 (*pfeifferi*, etc.).
Rabula Jordan & Davis, subgenus nova (*aquæ-dulcis*).

Type: *Gymnothorax reticularis* Bloch.

Etymology: Γυμνός, bare; θώραξ, breast; from absence of pectoral fins.

This genus, as here understood, comprises the great bulk of the *Murænidæ*, including all the species with sharp teeth, the body normally formed, and with the anterior nostrils only tubular. *Priodonophis* with serrated teeth has been recognized as a distinct genus by Bleeker, but the character in question disappears by degrees and seems not to be suitable for generic distinction.

The name *Gymnothorax*, first associated with a species of this genus and restricted to it by Dr. Günther, seems to be available for the group, rather than *Sidera* or *Thærodontis*. The name has, however, been usually regarded as synonymous with *Muræna*, rather than as a distinct genus.

The Morays of this genus are everywhere abundant in the tropical seas, where some of them reach a great size. For those species, some 8 or 10 in number, which have the dorsal fin inserted behind the head,

we have suggested the new subgeneric name of *Rabula*. Apparently, these species have not enough in common to justify the recognition of *Rabula* as a distinct genus.

ANALYSIS OF AMERICAN AND EUROPEAN SPECIES OF GYMNOTHORAX.

a. Dorsal fin beginning over or behind the gill-opening (*Rabula* Jordan & Davis).

b. Dorsal fin inserted far back, nearer vent than gill-opening. Eye moderate, over middle of gape; lower teeth uniserial, with canines in front; upper teeth biserial, the outer teeth small; vomer with strong canines in front, the posterior teeth small, uniserial; posterior nostril nearer eye than anterior one. Insertion of dorsal $1\frac{1}{4}$ lengths of the head before vent, much nearer vent than gill-opening. Tail longer than rest of body by the length of the jaw. Head 3 in trunk; gape $2\frac{2}{3}$ in head; eye 2 in snout. Color much as in *Gymnothorax mordax*, dark brown with irregular diffuse yellowish spots smaller than eye, which run together into irregular marblings; gill opening small, slightly dark; fins nearly plain; belly without dark cross-lines; teeth entire.......................................AQUÆ-DULCIS, 5.

bb. Dorsal inserted over or slightly behind gill-opening.

c. [Teeth in upper jaw uniserial; (dorsal fin in figure beginning a short distance behind gill-opening); color yellowish brown with dark reticulations, the longitudinal branching streaks studded with oblong yellow spots; spots on belly large, those on throat confluent; dorsal and anal yellowish brown with darker clouds; teeth all uniserial]. (*Kaup.*).......................................MARMOREUS, 6.

cc. Teeth of upper jaw biserial; tail longer than rest of body; color purplish brown, nearly plain.

d. Jaws not capable of being completely closed; some of the teeth serrate; outer teeth of jaws thickish, bent abruptly backward at tip, the posterior margin below distinctly serrate; lower jaw strongly bent upward towards the tip, the largest teeth on the bent anterior part of the jaws; teeth of the inner row above long, slender, and movable, twice as large as the outer teeth; teeth of inner row of lower jaw slender (all lost in specimen examined); vomerine teeth small, uniserial, blunt (slender and sharp according to Steindachner); head small, bluntish, $7\frac{1}{2}$ in body; tail a little longer than rest of body; gape $2\frac{1}{3}$ in head; eye $1\frac{1}{3}$ in snout; dorsal beginning over gill-opening; color dark bluish black, brownish on tail; pores on jaws whitish.......................................PANAMENSIS, 7.

dd. Jaws with straightish* commissure and hence completely closing; teeth all entire.

e. Tail about half longer than rest of body; dorsal beginning a little behind gill-opening; vomerine teeth slender and rather long; teeth in two series in each jaw, those of the inner series largest and movable; anterior canines enlarged; outer teeth of upper jaw bluntish and turned backward as in *G. panamensis;* snout short, bluntish; eye large; head $2\frac{3}{4}$ in trunk, $8\frac{2}{3}$ in total; gape short; color purplish brown, finely mottled with darker, the markings faint.

LONGICAUDA, 8.

ee. [Tail but little longer than rest of body; dorsal beginning over gill-opening; vomerine teeth blunt and rounded; teeth in two series in each jaw, those of the inner series longest, movable, and readily lost; anterior canines large; mouth large, the gape $2\frac{1}{7}$ to $2\frac{1}{2}$ in head; head 8 to $8\frac{1}{2}$ in length; eye small, 3 in snout, inserted over middle

* Character not verified in *G. porphyreus.*

of gape; color mottled purplish brown; on a clear brown ground many small dark-brown and whitish specks.] (*Steindachner.*) .... PORPHYREUS, 9.

aa. Dorsal beginning before gill-opening.

e. Teeth all entire, with no serrations anywhere. (GYMNOTHORAX).

f. Teeth simple, none of them with basal lobes.

g. Body without black transverse bands, or very large irregularly placed black spots.

h. Body without small, round, bluish-white or yellow spots, the spots, if any, blackish or dull grayish.

i. Dorsal with a distinct pale margin; anterior nasal tube very short; eye small, smaller than gill-opening; teeth on upper jaw and vomer and front of lower jaw, biserial; vomerine teeth blunt and rounded; canines small, bluntish, not much larger than other teeth; head $2\frac{1}{5}$ to $2\frac{2}{3}$ in trunk, $4\frac{1}{4}$ in tail; snout short and bluntish; cleft of mouth $3\frac{1}{6}$ in head; eye 3 in snout; tail longer than rest of body by about a head's length; color nearly uniform brown; sides of head and trunk often with brown angular markings forming an indistinct network; margin of dorsal and anal distinctly white; no dark streaks on dorsal; gill-opening small, somewhat dark; lips pale-edged; (color markings sometimes faint in old examples) .... UNICOLOR, 10.

ii. Dorsal without distinct paler margin, or with merely the very edge whitish.

j. Dorsal with a distinct black margin; anal with a pale edge.

k. Color nearly plain brown, finely freckled; teeth uniserial, about 13 on side of lower jaw; vomerine teeth small, in a short row posteriorly; eye near angle of mouth, 3 in snout; head $3\frac{1}{4}$ in trunk; tail about equal to head and trunk; color light chestnut-brown, finely freckled, but without distinct spots; dorsal with a conspicuous edge of blackish, the margin narrowly white; anal edged with white .... VERRILLI, 11.

kk. Color brownish, finely mottled with darker brown; teeth uniserial; lower jaw with about 22 teeth on each side; canines well developed; gill-openings narrower than the eye; eye large, 2 in snout, which is long, narrow, and pointed; mouth capable of being completely closed; cleft of mouth 2 to $2\frac{1}{3}$ in head; head long, about half length of trunk; tail longer than rest of body by about $\frac{2}{3}$ length of head; brown everywhere, finely mottled with darker brown or purplish; angle of mouth dusky; dorsal with a dusky edge, the fin marked with dark streaks as in *G. funebris;* anal edged with whitish; black spot at gill-opening faint or obsolete .... VICINUS, 12.

jj. Dorsal without distinct darker margin, its border colored like the fin (or slightly darker in deeply colored specimens).

l. (Body and tail with close set dark points; teeth uniserial; gill-opening larger than eye; tail longer than rest of body; depth of body $13\frac{2}{3}$ in length; head 3 in trunk; cleft of mouth not quite half head; olivaceous; head and tail with close-set dark points most distinct about gill-opening; snout chestnut; dorsal mottled with gray and yellow; anal with a yellow border.) (*Poey.*) .... VIRESCENS, 13.

ll. Body and tail not covered with close-set dark points.

m. Color olivaceous or blackish, with conspicuous markings, either paler or darker than the ground color; belly without distinct transverse lines.

n. Ground color yellowish or brownish, reticulated, marbled or spotted with brown or black.

o. Belly marbled or spotted like the back and sides.

p. Dark markings forming narrow reticulations, never rounded spots; body and tail light olive, everywhere covered with reticulations of dark lilac, the patches of ground color inclosed by the ultimate reticulations, mostly smaller than pupil; some of the reticulations more conspicuous and inclosing irregular polygons or squares considerably larger than eye; the lines are so branched that these markings are not easily traceable; margin of anal broadly yellowish; a trace of a pale line on edge of dorsal; teeth uniserial, stout, and strong, not close set; eye $2\frac{1}{3}$ in snout; cleft of mouth 2 to $2\frac{1}{2}$ in head; head $2\frac{1}{3}$ in trunk, $3\frac{1}{2}$ in tail, the tail slightly longer than rest of body. POLYGONIUS, 14.

pp. Dark markings in the form of rounded spots, which are more or less confluent, sometimes reducing the pale ground color to narrow reticulations on a surface of black; ground color yellowish, the body covered with brown or black spots of varying size, never much smaller than the pupil of the eye, and sometimes so largely confluent as to make the ground color appear as yellow reticulations on a face of black; relative extent of light and dark markings subject to very great variations; spots on head and snout generally smaller; each pore on lower jaw generally placed in a large pale spot; dorsal and anal fins spotted like the body; margin of anal fin narrowly yellowish, this marking obliterated in dark specimens; teeth uniserial, irregular in size in the jaws, those in the front of the mouth, long, slender canines; vomer with one or two large, depressible teeth in front and usually a row of small teeth behind; eye rather large, about 2 in snout ($2\frac{3}{4}$ to 3 in dark specimens, the pigment encroaching on the cornea, so that the eye seems notably smaller); cleft of mouth $2\frac{1}{4}$ in head; head 2 to 3 in trunk; tail usually a little longer than the head and trunk...MORINGA, 15.

oo. Belly nearly or quite immaculate. [Tail as long as rest of body; color, yellowish brown with darker marblings, very irregular; nasal tube short, scarcely half length of eye; muzzle obtuse, truncate; eye small, 3 in snout and 14 in head; gill-opening larger than eye; tail as long as rest of body; dorsal and anal low.] (*Sauvage.*) WIENERI, 16.

nn. Ground color brownish-black, with irregular pale-grayish spots; anal fin without distinct pale margin.

q. Cleft of mouth more than one half of head. [Snout produced, narrow, subspatulate; eye nearer to the end of snout than the angle of mouth; teeth irregularly biserial in jaws, uniserial on vomer; cleft of mouth very wide, rather more than one-half the length of head; eye, $2\frac{1}{2}$ in snout; head a little less than half of trunk; tail rather longer than rest of body; brownish black, with small, irregular, pale-grayish spots in moderate number and longitudinally arranged, the largest sometimes twice the size of the eye, the smallest mere dots, each spot marbled with darker; head brownish yellow, with indistinct yellow dots above.] (*Günther.*) ANATINUS, 17.

qq. Cleft of mouth, less than half of head; [teeth of jaws irregularly biserial; vomerine teeth biserial; snout rather produced and narrow; eye situated above the middle of gape, $2\frac{1}{2}$ in snout; cleft of mouth contained $2\frac{1}{4}$ in head; head $2\frac{1}{2}$ in trunk; tail longer than rest of body; brownish black, with numerous, rather irregular pale-grayish spots, the largest about the size of the eye, the smallest mere dots; each spot again marbled with darker, the smaller and larger spots mixed together.] (*Günther.*) SANCTÆ-HELENÆ, 18.

mm. Color dark brown, dark green, or blackish, either plain or with faint markings.

r. Belly with black, wavy transverse lines; no dark lines along dorsal fin; body with obscure paler spots and marblings; teeth of upper jaw biserial; teeth in the inner row very large and movable; teeth of lower jaw uniserial, close set, compressed, recurved, like outer teeth of upper jaw; vomerine teeth small, uniserial, preceded by very large, depressible canines. Eye small, $3\frac{1}{4}$ in snout, midway between tip of snout and angle of mouth; cleft of mouth $2\frac{1}{4}$ to $2\frac{3}{4}$ in head; head $2\frac{2}{3}$ to $3\frac{1}{3}$ in trunk; tail shorter than rest of body. Dark brown, vaguely reticulated, with narrow, paler streaks and spots, the markings very obscure; belly with dark cross streaks; a dark blotch around gill-opening .... MORDAX, 19.

rr. Belly without black transverse lines.

s. Tail a little longer than head and trunk. Teeth uniserial in the jaws in the adults; teeth on vomer uniserial (var. ? *erebus*), or biserial (*funebris*); long depressible canines on front of vomer; eye 2 to $2\frac{1}{2}$ in snout, above

middle of gape; cleft of mouth $2\frac{1}{2}$ in head; head $2\frac{1}{2}$ in trunk; color dark olive-brown, nearly plain, paler on throat, sometimes with very faint darker marblings; dorsal and anal fins with dark lines running longitudinally; jaws not completely closing .... FUNEBRIS, 20.

ss. [Tail considerably shorter than head and trunk. Teeth of maxillary and the anterior of mandible biserial, the others uniserial; jaws completely closing; eyes small, somewhat nearer to the end of the snout than to the corner of the mouth; cleft of mouth $2\frac{1}{2}$ in head; head 3 in trunk. Color, coffee-brown, irregularly marbled with darker.] (*Günther.*) .... CHILENSIS, 21.

hh. Body with distinct small blue, white, or yellow spots.

t. Dorsal and anal without a distinct colored margin; pale spots on body usually smaller than eye.

u. Teeth of upper jaw uniserial.

v. Vomerine teeth uniserial. Teeth all uniserial, those on lower jaw small, compressed, directed backwards; front of lower jaw with several canines; upper with some fixed canines among the other teeth; head 2 to $2\frac{1}{2}$ in trunk; cleft of mouth 2 to $2\frac{1}{2}$ in head; tail longer than body. Brownish or blackish, with small round bluish or yellowish spots, ocellated or not, these spots scattered, irregular in position, and smaller than eye; dorsal colored like the back . DOVII, 22.

vv. [Vomerine teeth biserial; mandible with about 17 teeth on each side. Head $2\frac{1}{2}$ in trunk; tail but little longer than rest of body; entire body covered with small blue dots one-sixth the diameter of the eye, the distance between them being equal to the diameter of eye; front and top of head without dots; dorsal with vertical cross streaks of bluish.] (*Poey.*) .... CONSPERSUS, 23.

uu. Teeth of upper jaw biserial; body with many small yellow spots.

w. Vomerine teeth uniserial, mostly small and rounded.

x. [Color nearly uniform from head to tail; brown or black, entirely covered with innumerable yellowish dots, the largest the size of a small pin head. Teeth biserial, except on vomer and the side of mandible; canines small; mouth can be shut completely; gill-opening as wide as eye; eye 2 in snout; cleft of mouth 2¼ in head; head 2½ in body; tail rather longer than rest of body.] (*Günther.*)........MILIARIS, 24.

xx. [Color not uniform from head to tail; tail black with innumerable round yellow spots smaller than eye; towards the trunk the yellow spots are more densely crowded and irregular in shape, and on the head the yellow becomes the ground color and the black appears in the form of reticulations. Teeth biserial, except on vomer and side of mandible; the mouth can not be completely shut; gill-opening rather wider than eye; eye less than one-half of snout; head 2½ in trunk; tail rather longer than the rest of body.] (*Günther.*)... FLAVOPICTUS, 25.

ww. Vomerine teeth biserial, small, and bluntly rounded. Mouth not closing completely; teeth of upper jaw biserial, those of the inner series larger; teeth of the lower jaw biserial anteriorly; eye over middle of gape, 2¼ in snout; head 2⅗ in trunk, 4¼ in tail, which is a little longer than rest of body; gill-opening large. Color, dark brown, faintly mottled with darker, the whole body, including fins, covered with points of clear yellow, those on the head close-set and minute, like needle points, but as large as a pin's head on the tail; (middle of body with intricate markings of yellow in the form of linear dashes according to Poey; none shown on our specimen.)

ELABORATUS, 26.

tt. Dorsal with a blackish border, interrupted with white; anal with a white margin. [Anterior teeth of upper jaw long and sharp, the rest small and in one series; vomerine teeth in one row, three large canines in front, the rest small; teeth on lower jaw small, with two longer ones on each side in front; head $2\frac{1}{4}$ in trunk; cleft of mouth 2 in head; tail a head's length longer than the rest of the body. Body marbled with brown on a greenish ground, dark enough to almost obscure the marblings, which are composed of close-set spots as large as the pupil, often bordered on one side with a white edging, the spots sometimes being all white; dorsal fins with a blackish border, sometimes interrupted with white; anal all black, with a white border.] (*Poey.*) ..... OBSCURATUS, 27

gg. Body with black transverse bands, or large irregularly placed black spots.

a. [Color brown, with large black spots irregularly dispersed over the body; fins yellowish; teeth 16 in outer row, 7 in inner; vomerine teeth 10, in 2 rows with an anterior and posterior larger tooth; teeth biserial; tail a little longer than rest of body.] (*Kaup.*) IRREGULARIS, 28.

aa. Color pale yellowish brown with about 20 blackish rings, which are usually three times the breadth of the interspaces; these rings broadest above, extending over the fins; tip of tail black; head with $3\frac{1}{2}$ rings which do not meet below; tip of snout in one ring, the top and front of snout on median line pale; upper teeth biserial, the rest uniserial; dentary with about 14 teeth on each side; eye 2 in snout, midway between tip of snout and angle of mouth; head $2\frac{2}{3}$ in trunk; head and trunk a little shorter than tail; mouth completely closing .... CHLEVASTES, 29.

ff. [Teeth, some or all of them with basal lobe. Teeth all uniserial; 12 teeth on each side of lower jaw; snout short, obtuse; eye small, $\frac{2}{3}$ the length of the snout; tail rather shorter than rest of body. Brown, with irregular blackish venules.] (*Kaup* per *Günther.*) MODESTUS, 30.

ee. Teeth serrate, more or less. (*Priodonophis* Kaup.)

b. [Color uniform blackish brown; anterior part of body with short undulating lines. Gill-opening scarcely larger than the eye; vomer toothless; teeth of both jaws in single series, each

tooth slightly serrate behind; tail shorter than rest of body; head $3\frac{1}{2}$ in trunk.] (*Günther.*)

MADEIRENSIS, 31.

bb. Color brown above; lighter below, with irregular light-yellowish spots, variable in size and sometimes so thickly placed that the ground work appears as brown reticulations; dorsal fin with large dark spots on the edge, the spots often running together so as to form a black band (or sometimes obsolete); anal fin with a dark edge. Teeth all uniserial in jaws, rather large and strong, the posterior edge of the larger teeth serrate, like the teeth of a shark; vomer with few small teeth or none; jaws nearly or quite closing; head 2 to $2\frac{1}{2}$ in trunk, $3\frac{1}{2}$ to $4\frac{1}{2}$ in tail; eye $1\frac{1}{4}$ to $1\frac{3}{4}$ in snout; cleft of mouth $2\frac{1}{2}$ to 3 in the head; tail a little longer than rest of body.... OCELLATUS, 32.

x. Edge of dorsal and anal with confluent black blotches, forming a dark margin to the fin, the anal chiefly black.

y. Dark ground color forming reticulations around roundish and polygonal pale spots of various sizes, these larger on the tail, the spots everywhere much wider than the interspaces.

Var. *Saxicola*, 32*b*.

yy. Dark ground color covered with rounded whitish spots, which are not so wide as the interspaces, the spots subequal.

z. Spots of moderate size, much larger than pupil; rounded and yellowish; cheeks coarsely spotted..... Var. *Ocellatus*, 32*a*.

zz. Spots very small, stellate, not much larger than pupil; spots whitish; cheeks finely spotted like the rest of the body; body slender, a dusky shade along sides; fins chiefly black.

Var. *Nigromarginatus*, 32*c*.

xx. Edge of dorsal and anal without black; body dark, with small rounded whitish spots, much as in var. *ocellatus*.

Var. *Januarius*, 32*d*.

5. GYMNOTHORAX AQUÆ-DULCIS.

Muræna aquæ-dulcis Cope, U. S. Geol. Survey Montana, etc., 471, 1872. (Rio Grande, Costa Rica.)
Rabula aquæ-dulcis, Jordan & Davis.

Habitat: Pacific coast of Tropical America.

Etymology: *Aqua dulcis*, fresh water.

We refer to this species a specimen (6673, U. S. N. M.) said to have been collected at San Diego, California, by Dr. J. G. Cooper. It probably came from farther south. This specimen differs somewhat from Cope's description, but, like Cope's fish, it differs remarkably from all other known species of the genus in the insertion of the dorsal. We have not much doubt of the correctness of our identification.

The species resembles the young of *G. mordax*, and it may have been overlooked by San Diego collectors on account of this resemblance. It probably does *not* occur in fresh waters.

6. GYMNOTHORAX MARMOREUS.

Murænophis marmoreus Valenciennes, Voy. Venus, Zool., 347, 1855, pl. 10, fig. 1 (Galapagos Islands).

Habitat: Galapagos Islands.

Etymology: Latin, marbled.

This species is known only from the accounts given of the original type, a stuffed example, 21 inches long, obtained by Freminville at the Galapagos. It may be identical with *G. aquæ-dulcis*, or even with *Muræna lentiginosa*, but this is less likely.

7. GYMNOTHORAX PANAMENSIS.

Muræna panamensis Steindachner, Ichth. Beit., v, 19, 1876 (Panama).
Sidera panamensis Jordan & Gilbert, Proc. U. S. Nat. Mus., 623, 1882 (Pearl Islands).

Habitat: Pacific coast of Central America.

Etymology: From Panama.

This species is known to us from a specimen taken at the Pearl Islands, near Panama, by Prof. Frank H. Bradley, and from another (6015, U. S. N. M.) said to be from "South America." From this specimen our description is taken. It differs from Steindachner's account in having the vomerine teeth blunt and the lower teeth in one row. This species is one of the most strongly marked in the genus, being well distinguished by the form of its teeth, its curved lower jaw, and posterior dorsal.

8. GYMNOTHORAX LONGICAUDA.

Muræna longicauda Peters, Monatsber. Kön. Acad. Wiss. Berlin, 850, 1876 (Atlantic Ocean, 15° 40′ N., 0° 5′ W.).

Habitat: Tropical Atlantic (same locality as *Sphagebranchus anguiformis*).

Etymology: *Longus*, long; *cauda*, tail.

This species is known from Dr. Peters's account of an individual taken in the open Atlantic, between the West Indies and Europe. Our description is taken from a small example from unknown locality, numbered 20515 in the Museum register. The species is near *panamensis*, from which it differs in the form of its mouth and some of its teeth. The tail is also very long, longer than in related species.

9. GYMNOTHORAX PORPHYREUS.

Muræna porphyrea Guichenot (Chile); Steindachner, Ichthyol. Beitr., II, 22, 1875 (rocky coasts of Juan Fernandez).

Habitat: Coasts of Chile.

Etymology: *Πορφυρεός*, purple.

This species is known to us only from Steindachner's description. It is said to be common and to reach a considerable size.

10. GYMNOTHORAX UNICOLOR.

Murænophis unicolor De la Roche, Ann. Mus., XIII, 359, fig. 15, 1809 (Iviça) (*fide* Günther).

Muræna unicolor Lowe, Trans. Zoöl. Soc., 192 (Madeira) (*fide* Günther); Costa, Faun. Nap. Pesc. (*fide* Günther); Günther, VIII, 125, 1870 (Algiers, Madeira, St. Helena).

Thyrsoidea unicolor Kaup, Apodes, 91, 1856 (Iviça, Madeira, Madagascar).

Muræna cristini Risso, Ich. Nice, 368, 1810 (Nice).

Muræna monaca Cocco (*fide* Kaup).

Thyrsoidea microdon Kaup, Apodes, 89, fig. 64, 1856 (no locality).

Habitat: Mediterranean fauna and Madeira Islands.

Etymology: Latin, one-colored.

Of this species we have examined one specimen taken at Athens, Greece, by Prof. Horace A. Hoffman, and two from Madeira, collected by Dr. Stimpson. The species has remarkably short nasal tubes.

11. GYMNOTHORAX VERRILLI.

Sidera verrilli Jordan & Gilbert, Proc. U. S. Nat. Mus., 623, 1882 (Panama); Jordan & Gilbert, Proc. U. S. Nat. Mus., 210, 1883; Jordan, Proc. U. S. Nat. Mus. 369, 1885 (Panama).

Habitat: Panama.

Etymology: Named for Prof. Addison E. Verrill.

This species is known from the typical example in the Museum of Yale College, collected by Professor Bradley at Panama.

12. GYMNOTHORAX VICINUS.

Murænophis vicina Castelnau, Anim. Amér. Sud, Poiss., 81, pl. 42, fig. 4, 1855 (Bahia).
Muræna vicina Günther, VIII, 121, 1870 (Bahia).
Thyrsoidea maculipinnis Kaup, Apodes, 83, 1856 (Gold Coast); Duméril, Arch. Mus., X, 260, pl. 28, fig. 1 (*fide* Günther); Bleeker, Verh. Holl. Maatsch. Haarl., 129, tab. 27, 1862 (*fide* Günther); Troschel, Wiegm. Arch., 237, 1866 (*fide* Günther).
Muræna maculipinnis Günther, VIII, 124, 1870 (Cape Verde Isl.; Fernando Po; Mexico).
Gymnothorax maculipinnis Jordan, Proc. U. S. Nat. Mus., 1890 (Bahia).
Thyrsoidea cormura Kaup, Aale Hamb. Mus., 23, 1859 (*fide* Günther).
Tæniophis cormura Kaup, l. c., tab. 3, fig. 2 (*fide* Günther).
Thyrsoidea marginata Kaup, l. c., 24 (*fide* Günther).
Tæniophis marginata Kaup, l. c., tab. 4, fig. 1 (*fide* Günther).
Gymnothorax versipunctatus Poey, Enumeratio, 156, 1875 (Cuba).

Habitat: Atlantic Ocean, West Indies to Cape Verde Islands and Africa.

Etymology: Latin, *vicinus*, near (to *Gymnothorax moringa*).

A specimen, collected by the *Albatross* at Bahia, seems to be identical with *Muræna vicina* of Castelnau, which was obtained in the same locality. This seems to be the same as the *maculipinnis* of Kaup, and we have therefore adopted the name *vicinus* instead of the latter name. Another specimen before us (6737, U. S. N. M., without locality) evidently belongs to the same species. We refer the names *cormura* and *marginata* to this species on the authority of Dr. Günther.

13. GYMNOTHORAX VIRESCENS.

Gymnothorax virescens Poey, Enumeratio, 156, 1875 (Cuba).

Habitat: West Indian fauna.

Etymology: *Virescens*, greenish.

This species is known only from Poey's account.

14. GYMNOTHORAX POLYGONIUS.

Gymnothorax polygonius Poey, Ann. N. Y. Lyc. Nat. Hist., 68, 1872 (Cuba); Poey, Enumeratio, 158, 1875.
Sidera vicina Jordan, Proc. U. S. Nat. Mus., 34, 1886 (Havana). (Not *Murænophis vicinus* Castelnau.)

Habitat: West Indian fauna.

Etymology: Latin, marked with polygons.

Of this species we have two examples. One of these was obtained by Dr. Jordan at Havana. It was at first identified as *Gymnothorax vicinus*, but Castelnau's species seems to be different from this. There is no doubt that this is the original of Poey's *G. polygonius*, although the polygonal markings are very obscure. The other specimen (9825 U. S. N. M., 28 inches long) was sent from Cuba by Poey. It agrees perfectly with our specimen, and it may be Poey's original type.

15. GYMNOTHORAX MORINGA.

(COMMON MORAY; HAMLET.)

Muræna maculata nigra (the Black Moray) Catesby, Nat. Hist. Carolina, tab. 21, 1738 (Bahamas, etc.).

?? *Gymnothorax afer* Bloch, Ichth., pl. 417, 1795 (Africa).

Muræna moringa Cuvier, Règne Animal, ed. II, 1828 (after Catesby); Günther, VIII, 120, 1870 (Bahia; Cuba; Jamaica; Dominica; St. Croix; Bonacca; St. Helena).

Gymnothorax moringa Goode, Bull. U. S. Nat. Mus., V, 72, 1876 (Bermuda); Goode & Bean, Proc. U. S. Nat. Mus., 240, 1882.

Sidera moringa Jordan. Proc. U. S. Nat. Mus., 1884, 111 (Key West); Bean & Dresel, ibid, 169 (Jamaica); Jordan, Cat. F. N. A., 52, 1885; Jordan, Proc. U. S. Nat. Mus., 34, 1886 (Havana); Jordan, ibid, 566.

Gymnothorax rostratus Agassiz, Spix, Pisc. Bras., 91, tab. 50 *a*, 1830 (Brazil); Poey, Repertorio, II, 259, 1868 (Cuba); Poey, Synopsis, 427, 1868; Cope, Trans. Amer. Phil. Soc., 483, 1876 (St. Martin's; St. Kitts; New Providence).

Murænophis rostratus Castlenau, Anim. Amér. Sud, 80, pl. 42, fig. 1, 1855 (Rio Janeiro).

Muræna rostrata Poey, Conspectus, 386, 1868 (Cuba).

Muræna moringua Richardson, Voy. Erebus and Terror, Fishes, 89, 1844 (Jamaica).

Thyrsoidea moringua Kaup, Apodes, 79, 1856.

Muræna punctata Gronow, Cat. Fish., 18, 1854 (rivers of North America).

Murenophis curvilineata Castelnau, Anim. Amér. Sud, Poiss., 81, pl. 42. fig. 2, 1855 (Rio Janeiro).

Murenophis caramuru Castelnau, Anim. Nouv. Rares, Amérique du Sud, 85, pl. 43, fig. 1, 1855 (Bahia).

Gymnothorax flavoscriptus Poey, Enumeratio, 158, 1875 (Cuba).

Gymnothorax picturatus Poey, Anal. Soc. Esp. Hist. Nat., 257, 1880 (Cuba).

Habitat: West Indian fauna, ranging from Pensacola to Rio Janeiro and St. Helena.

Etymology: Moringa, a West Indian corruption of *Muræna* (Moray, Morena, etc.).

This large moray is the commonest species of the group in the West Indies, where it is everywhere abundant. The specimens before us are from Key West, Havana, and the Snapper Banks near Pensacola. The species varies considerably in shade of coloration and extent of the dark markings. The general pattern is, however, very uniform. The specimens before us vary in such a way as to suggest at first examination the existence of four distinct species. Besides the ordinary form of *moringa*, there are specimens from coral sand at Key West, very pale, with the pale markings predominating over the dark spots. This form is known to the fishermen as "Hamlet." A specimen from Havana is almost black, with no pale margin to the anal, and the eye appears very much smaller, $3\frac{1}{2}$ in the snout. This is, however, due to the encroachment of the black pigment on the eye, as the pupil itself is as large as in the others. Two large specimens from the Snapper Banks are also very dark, and in one the dorsal and anal fins are distinctly dusky towards and on the edge. In these the black markings reduce the ground color to narrow streaks and disconnected reticulations. There is, however, no reason to doubt that all belong to a single variable species. The dentition is alike in all.

16. GYMNOTHORAX WIENERI.

Gymnothorax wieneri Sauvage, Bull. Soc. Philom., VII, 161, 1883 (Chile or Peru).

Habitat: Pacific coast of South America.

Etymology: Named for the person who first obtained the type.

This is a doubtful species of uncertain relations. It may be identical with the equally doubtful *marmoreus*.

Following is Sauvage's original description of *Gymnothorax wieneri:*

Dents du maxillaire et de l'intermaxillaire en une seule rangée; dents palatines plus longues que celles du maxillaire, au nombre de 3 ou 4; deux ou trois fortes dents au vomer; pas de canines; tube nasal court, n'ayant guère que la moitié du diamètre vertical de l'œil. Museau obtus, tronqué; œil petit, le diamètre étant compris près de trois fois dans la longueur de la tête, situé au-dessus du milieu de la longueur de la bouche. Ouverture branchiale plus grande que le diamètre de l'œil. Queue de la même longueur que l'espace compris entre l'extrémité du museau et l'anus. Dorsale et anale basses. Jaune brunâtre avec des marbrures foncées, très irrégulières; ventre blanc jaunâtre sans taches. Longueur m. 0.760. Chili ou Pérou. *Wiener.*

17. GYMNOTHORAX ANATINUS.

Muræna anatina Lowe, Trans. Zöol. Soc. Lond., II, 192, 1842 (Madeira); Günther, VIII, 115, 1870 (Madeira).

Habitat: Madeira.

Etymology: *Anatinus*, duck-like.

This species is known to us from descriptions.

18. GYMNOTHORAX SANCTÆ-HELENÆ.

Muræna sanctæ-helenæ Günther, VIII, 115, 1870 (St. Helena); Bean, Proc. U. S. Nat. Mus., 113, 1880 (Bermuda Islands); Günther, Proc. Zöol. Soc. Lond., 239, 1881.

Habitat: Tropical Atlantic.

Etymology: From St. Helena.

This species we know only from the accounts given by Günther and Bean. It is certainly very close to *Gymnothorax anatinus.*

19. GYMNOTHORAX MORDAX.

(CALIFORNIA CONGER EEL.)

Muræna mordax Ayres, Proc. Acad. Nat. Sci. Cal., 30, 1859 (Cerros Island); Jordan & Gilbert, Proc. U. S. Nat. Mus., 457, 1880 (San Pedro, San Diego); Jordan & Gilbert. Syn. F. N. A., 356, 1883; Jordan & Gilbert, Proc. U. S. Nat. Mus., 36, 1881 (Point Conception to Santa Barbara Islands); Smith, Proc. U. S. Nat. Mus., 233, 1883 (Todos Santos Bay).

Gymnothorax mordax Jordan, Proc. U. S. Nat. Mus., 30, 1880.

Sidera mordax Jordan & Gilbert, Proc. U. S. Nat. Mus., 210, 1883.

Habitat: Pacific coast from Point Conception to Cerros Island.

Etymology: *Mordax*, prone to bite.

This large Moray is common among the rocks on the coast of southern California. The numerous specimens before us are from Santa Barbara and San Diego.

20. GYMNOTHORAX FUNEBRIS.

(BLACK MORAY; MORENA VERDE.)

Muræna maculata nigra et viridis (The Moray), Catesby, Nat. Hist. Carolina, tab. 20, 1738 (Bahamas).
Gymnothorax funebris Ranzani, Nov. Comm. Ac. Sc. Inst. Bonon., IV, 76, 1840 (Brazil).
Sidera funebris Bean & Dresel, Proc. U. S. Nat. Mus., 169, 1884 (Jamaica); Jordan, Proc. U. S. Nat. Mus., 110, 1864 (Key West); Jordan, Cat. F. N. A., 52, 1885.
Muræna lineopinnis Richardson, Voy. Erebus and Terror, Fish., 89, 1844 (Puerto Cabello).
Thyrsoidea lineopinnis Kaup, Apodes, 82, 1856.
?*Muræna prasina* Richardson, Voy. Erebus and Terror, Fish., 93, 1844 (Australia) (*fide* Günther).
?*Muræna boschii* Bleeker, Verh. Bat. Gen. Mur., XXV, 52, 1853 (Sumatra) (*fide* Günther).
?*Gymnothorax boschii* Bleeker, Atlas Ichth. Mur., 105, pl. 46, fig. 3, 1864 (Sumatra and Java).
?*Muræna monochrous* Bleeker, Nat. Tyds. Ned. Ind., 384, 1856 (Ternate).
?*Gymnothorax monochrous* Bleeker, Atlas Ichth. Mur., 116, pl. 47, fig. 2, 1864 (Singapore; Sumatra; Ternate; Amboyna) (*fide* Günther).
Tæniophis westphali Kaup, Aale Hamburg. Mus., Nachtrag, 1, 1859 (*fide* Günther).
Thyrsoidea aterrima Kaup, Aale Hamburg. Mus., 22, 1859 (*fide* Günther).
Tæniophis aterrima Kaup, l. c., tab. 3, fig. 1. 1859.
Muræna aterrima Günther, VIII, 124, 1870 (Dominica).
Muræna infernalis Poey, Memorias, II, 347, 354, 1860 (Cuba).
Gymnothorax infernalis Poey, Repertorio, II, 278, 1868; Poey, Synopsis, 426, 1868.
Thyrsoidea concolor Abbott, Proc. Acad. Nat. Sci. Phila., 479, 1860 (Vera Cruz).
Muræna erebus Poey, Memorias, II, 426 (Cuba).
Gymnothorax erebus Poey, Repertorio, II, 258, 1828; Poey, Synopsis, 427, 1868; Poey, Enumeratio, 155, 1875.
?*Gymnothorax jacksoniensis* Bleeker, Versl. Med. Akad. Wet. Amsterd., 450, 1863 (*fide* Günther).
?*Muræna afra* Günther, VIII, 123, 1870 (not of Bloch).
Sidera castanea Jordan & Gilbert, Proc. U. S. Nat. Mus., 647, 1882 (Mazatlan); Jordan & Gilbert, Proc. U. S. Nat. Mus., 210, 1883 (Mazatlan).

Habitat: Tropical America on both coasts. Florida to Brazil; Mazatlan to Panama. Also recorded from the East Indian Archipelago and Australia.

Etymology: *Funebris*, funereal, from its dark color.

This large Moray is one of the commonest and most widely distributed of the American species, being found in abundance on both coasts in tropical America. If we can trust to the synonymy of Dr. Günther the same species is also widely distributed in the East Indies, but we have had no opportunity to compare specimens of the Old World form called *prasinus*, *boschi*, or *monochrous* with the American *funebris*.

We have not adopted the name *afer*, used for the species by Günther, because the figure of *Gymnothorax afer* given by Bloch by no means represents the color of our species and was probably intended for something else. It is, in fact, as Poey has suggested, much more like *moringa*. There is no doubt of the identity of *funebris*, *concolor*, *castanea*, and *infernalis*. The *erebus* of Poey is said to agree in color, but to differ in the dentition of the vomer. The vomerine teeth are

uniserial in *crebus*, biserial in *infernalis*. This is probably dependent on age, or perhaps the variation of individuals. *Gymnothorax funebris* is one of the largest of the Morays, reaching a length of 4 or 5 feet and a diameter to correspond. The examples examined by us are from Key West, Bahia, St. Lucia, and Mazatlan.

21. GYMNOTHORAX CHILENSIS.

Muræna chilensis Günther, Proc. Zoöl. Soc. Lond., 674, 1871 (Chile).

Habitat: Chile.

Etymology: From Chile.

This species is known to us only through Dr. Günther's description.

22. GYMNOTHORAX DOVII.

(ANGUILA PINTITA.)

Muræna dovii Günther, Cat. Fish., VIII, 103, 1870 (Panama); Jordan & Gilbert, Proc. U. S. Nat. Mus., 378, 1882 (Espiritu Santo Island; Galapagos Islands).

Sidera dovii Jordan, Bull. U. S. Fish Com., 106, 1882 (Mazatlan); Jordan & Gilbert, Proc. U. S. Nat. Mus., 209, 1883.

Muræna pintita Jordan & Gilbert, Proc. U. S. Nat. Mus., 346, 1881 (Mazatlan).

Habitat: Pacific coast of tropical America.

Etymology: Named for Capt. John W. Dow.

This species is not rare on the Pacific coast of tropical America. It varies somewhat in the number and arrangement of its pale spots. An examination of several examples has convinced us of the identity of *pintita* and *dovii*.

23. GYMNOTHORAX CONSPERSUS.

Murænophis punctata Castelnau, Anim. Nouv. Rares Amer. Sud, 82, 1855 (Rio Janeiro). (Not *Gymnothorax punctatus* Bloch.)

Gymnothorax conspersus Poey, Repertorio, II, 259, 1868 (Cuba); Poey, Synopsis, 427, 1868; Poey, Enumeratio, 159, 1875.

Muræna conspersa Günther, 102, 1870.

Habitat: West Indian fauna.

Etymology: Latin, *conspersus*, speckled.

This species is known to us only from descriptions. The earlier name, *punctatus*, is preoccupied.

24. GYMNOTHORAX MILIARIS.

Thyrsoidea miliaris Kaup, Apodes, 90, 1856 (Martinique).

Muræna miliaris Günther, VIII, 100, 1870 (Cuba).

Gymnothorax miliaris Cope, Trans. Amer. Phil. Soc., 482, 1870 (St. Martin's); Poey, Enumeratio, 159, 1875 (Cuba).

? *Muræna multiocellata* Poey, Memorias, II, 324, 1860 (Havana).

? *Gymnothorax multiocellatus* Poey, Repertorio, II, 260, 1868 (Havana).

Gymnothorax scriptus Poey, Repertorio, II, 261, 1868 (Cuba); Poey, Synopsis, 427, 1868.

Habitat: West Indian fauna.

Etymology: *Mille*, thousand; from the number of spots.

This species is known to us only from descriptions.

Gymnothorax multiocellatus of Poey seems to be nearly or quite identical with *G. miliaris*, differing apparently only in the smaller spots. It agrees fairly with *elaboratus*, but the vomerine teeth are said to be uniserial. They are biserial in *elaboratus*.

25. GYMNOTHORAX FLAVOPICTUS.

Thyrsoidea flavopicta Kaup. Apodes, 90, 1856 (Brazil).
Muræna flavopicta Günther, VIII, 101, 1870 (St. Helena).

Habitat: Coast of Brazil to St. Helena.

Etymology: Latin *flavus*, yellow; *pictus*, painted.

This species is known to us only from descriptions.

26. GYMNOTHORAX ELABORATUS.

Muræna elaborata Poey, Memorias, II, 323, 1860 (Cuba).
Gymnothorax elaboratus Poey, Repertorio, II, 262, 1868; Poey, Syn., 427, 1868; Poey, Enumeratio, 159, 1875 (Cuba).

Habitat: Coast of Cuba.

Etymology: Latin, elaborate, from the markings.

This species is known to us from a single specimen (24961) sent from Cuba by Poey. The coloration of this specimen shows few or none of the linear dashes described by Poey. Its color agrees better with Poey's *multiocellatus*, but it has the dentition ascribed to *elaboratus*.

27. GYMNOTHORAX OBSCURATUS.

Gymnothorax obscuratus Poey, Ann. N. Y. Lyc. Nat. Hist., IX, 320, 1870 (Cuba); Poey, Enumeratio, 159, 1875.

Habitat: Cuba.

Etymology: Latin, obscured.

This species is known only from Poey's description.

28. GYMNOTHORAX IRREGULARIS.

Thyrsoidea irregularis Kaup, Apodes, 95, 1856 (Brazil).
Muræna irregularis Günther, VIII, 115, 1870 (copied).

Habitat: Coast of Brazil.

Etymology: Latin, irregular.

This species is only known from Kaup's scanty description.

29. GYMNOTHORAX CHLEVASTES.

Sidera chlevastes Jordan & Gilbert, Proc. U. S. Nat. Mus., 208, 1883 (Galapagos Islands).

Habitat: Galapagos Islands.

Etymology: *Χλευαστής*, a harlequin.

This strongly marked species is known only from the original type from the Galapagos Archipelago.

30. GYMNOTHORAX MODESTUS.

Muræna modesta Kaup, Aale Hamburg. Mus., 21, tab. 4, fig. 2, 1859 (*fide* Günther) (Valparaiso); Günther, VIII, 126, 1870.

Habitat: Coast of Chile.

Etymology: Latin, modest.

This species is known only from Kaup's scanty description.

31. GYMNOTHORAX MADEIRENSIS.

Pseudomuræna madeirensis Johnson, Proc. Zoöl. Soc. Lon., 167, 1860 (Madeira).
Muræna madeirensis, Günther, VIII, 125, 1870 (Madeira).

Habitat: Madeira Islands.

Etymology: From Madeira.

This species is known to us only from descriptions.

32. GYMNOTHORAX OCELLATUS.

(*a*) Var. *Ocellatus.*

Gymnothorax ocellatus Agassiz, Spix. Pisc. Brasil, 91, tab. 50*b*, 1828 (*fide* Günther). Schomburgk, Reis. Brit. Guiana, 639, 1842; Goode & Bean, Proc. U. S. Nat. Mus., 154, 1879 (West Florida); Goode & Bean, ibid, 344 (Clear Water Harbor).

Muræna ocellata Jenyns, Voy. Beagle, 145, 1842 (Rio Janeiro); Richardson, Voy. Erebus and Terror, 82, pl. 47, figs. 6–10, 1844; Günther, VIII, 102, 1870; Jordan & Gilbert, Syn. Fish. N. A., 356, 1883 (description).

Murænophis ocellatus Castelnau, Anim. Amérique Sud, Poiss., 82, 1855 (Bahia).

Priodonophis ocellatus Kaup, Aale Hamburg. Mus., 22, 1859; Kner, Novara Fische, 383, 1857 to 1859 (Rio Janeiro); Poey, Repertorio, II, 262; Poey, Syn. 427, 1868; Poey, Enumeratio, 159, 1875.

(*b*) Var. *Saxicola.*

Muræna meleagris Quoy & Gaimard, Voy. Freycinet, Zoöl., 245, pl. 52, fig. 2 (*fide* Günther) (not of Shaw).

Priodonophis meleagris Poey, Repertorio, II, 262, 1867: Poey, Syn., 428, 1868 (Cuba).

Muræna ocellata Jordan & Gilbert, Proc. U. S. Nat. Mus., 260, 1882 (Pensacola, Fla.).

Sidera ocellata Jordan & Gilbert, Proc. U. S. Nat. Mus., 209, 1883; Jordan, Proc. Acad. Nat. Sci. Phila., 42, 1884 (Egmont Key); Jordan, Proc. U. S. Nat. Mus., 34, 1886 (Havana).

Gymnothorax ocellatus saxicola Jordan & Davis, var. nov. (Snapper Banks at Pensacola).

(*c*) Var. *Nigromarginatus.*

Neomuræna nigromarginata Girard, U. S. and Mex. Bound. Surv., 76, pl. 41, 1859 (St. Joseph Island, Texas).

Sidera nigromarginata Jordan & Evermann, Proc. U. S. Nat. Mus., 473, 1886 (Pensacola, Fla.).

(*d*) Var. *Januarius.*

Gymnothorax variegatus Castelnau, Anim. Amér. Sud, Poiss. (not *Muræna variegata* Lacépède), 83, pl. 43, fig. 2, 1855 (Rio Janeiro) (said to have the dorsal without dark spots).

Gymnothorax ocellatus januarius Jordan & Davis (after Castelnau).

Habitat: West Indian fauna, Pensacola to Rio Janeiro.

Etymology: Latin, ocellate.

This small moray is rather common in the West Indies and northward to the coast of Florida. The numerous specimens before us are from Havana and the Snapper Banks, Cedar Keys, and Pensacola. This species differs from most of the other eels in having serrated teeth; this character seems to pass by degrees into the ordinary type and does not apparently justify the retention of a distinct genus (*Priodonophis*=*Neomuræna*=*Pseudomuræna*). This species varies considerably in color, a fact which has given rise to the recognition of some of its forms as distinct species. These forms seem to be absolutely alike in every respect except the coloration, and their differences are probably due to differences in the surroundings.

The form with very large spots, the ground color being reduced to reticulations, called by Poey *meleagris*, abounds about the Snapper Banks among rocks at a considerable depth. The name *meleagris* being preoccupied, we have called this form var. *saxicola*, and we regard it as a deep-water form. The two known specimens of the fine-spotted form, *nigromarginatus*, are from very shallow water on sandy bottom. The form called *variegata* by Castelnau we have not seen. As the name is preoccupied we have substituted that of *januarius*.

Genus 6.—MURÆNA.

Muræna Artedi, Gen. Pisc., 23, 1738 (in part; includes all eels).

Muræna Klein, Hist. Pisc. Nat., 28, 1742 (in part; includes all eels without pectoral fins).

Muræna Linnæus, Syst. Nat., ed. x, 243, 1758 (*helena*, etc., includes all eels).

Muræna Thunberg & Ahl, De Muræna et Ophictho, 6, 1789 (restricted to *helena*, etc.; includes species without pectoral fins).

Muræna Günther and of authors generally (not of Bleeker).

Gymnothorax Bloch, Ichthyologia, 1795 (in part, not type).

Murænophis Lacépède, Hist. Nat. Poiss., v, 630, 1803 (*helena*, etc.).

Limamuræna Kaup, Apodes, 95, 1856 (*guttata*).

Type: *Muræna helena* L.

Etymology: *Μύραινα* (Moray), ancient name of *Muræna helena*.

This genus as now restricted contains some ten species of the tropical seas, distinguished from *Gymnothorax* and from the rest of the family by the presence of two nasal barbels.

The name *Muræna*, originally applied to all eels, should be restricted to the type of *Muræna helena* as we have already shown. It was first limited by Thunberg & Ahl in 1789 to the eels without pectoral fins, those with such fins being set off as *Ophichthus*.

The restriction of *Muræna* to *Muræna anguilla* is much later.

ANALYSIS OF AMERICAN AND EUROPEAN SPECIES OF MURÆNA.

a. Teeth of sides of upper jaw* in one series; all the teeth uniserial in the adult (sometimes biserial in young, in upper jaw).

b. Mouth capable of being completely closed, the jaws being nearly straight along the commissure.

c. Body without sharply defined round pale spots. Ground color leather-brown, with large, irregular whitish or yellowish blotches inclosing brown spots; head and neck freckled with whitish spots; spots on tail smaller and more definite; anal fin with whitish spots. Teeth all uniserial, those of jaws large and strong, three canines in the front of vomerine series; eye 2½ in snout, placed over middle of gape; head 2½ to 3 in trunk; tail ⅙ longer than rest of body .... HELENA, 33.

cc. Body with round pale spots most numerous on the belly and tail. Teeth all uniserial, entire, directed backwards, most of them movable; lower teeth 12 on each side rather remote and comparatively large; no larger canines in front of upper jaw; teeth of upper jaw subequal, about 12 on each side, those in front smallest; vomerine teeth small, uniserial, directed backward; posterior nasal tubes well developed, nearly as large as anterior; dorsal beginning before gill-opening; eye over middle of gape, 2½ in snout; snout 2 in gape; head 2½ in trunk; gape 2¼ in head; head and trunk a trifle shorter than tail. Color very dark leather-brown or almost black; throat marbled with paler; a black spot around gill-opening; dorsal mottled with grayish; posterior part of body with a few scattered round grayish spots about as large as pupil; these irregular in size and position and rather faint, most numerous around vent and on anal fin; sides of tail nearly or quite plain; angle of mouth dark .... INSULARUM, 34.

ccc. [Body with three rows of diffuse yellowish blotches including fine spots. Color clear brown with a reddish tinge; very small yellow spots covering head, body, and fins, mixed here and there with larger spots; large yellowish blotches arranged in three rows along the body; the lower row fainter than upper. Teeth all uniserial; those of upper jaw strong, sharp-pointed, recurved; vomerine teeth much smaller, preceded by two long canines; head 6½ in total length; eye 2½ in snout; snout 5½ in head.] (*Steindachner*) .... ARGUS, 35.

bb. Jaws curved along the gape so that they can not be completely closed. Body covered by well-defined reticulations, inclosing light yellowish-brown spots, which posteriorly are arranged in groups of 5 to 8; gill-opening largely black, within a conspicuous dark blotch; angle of mouth with a dark spot; inside of mouth with yellowish brown spots; vomerine teeth small, sharp; teeth all uniserial, large and strong in the jaws; those in front not enlarged; head 2¾ to 3 in trunk; tail a little longer than rest of body .... RETIFERA, 36.

aa. Teeth of sides of upper jaw biserial, those of the inner series larger and farther apart.

d. Jaws capable of being completely closed.

e. Body profusely spotted; angle of mouth with little or no black; gill-opening dusky; general color brown, the body with light yellow, distinctly brown-edged spots, which are about as large as pupil of eye, sometimes larger; towards the end of tail the dark edgings form brown spots; snout, jaws, and belly spotted, as also the dorsal and anal; a faint, dusky bar from base of dorsal to behind cleft of mouth; spots more numerous around gill-openings; teeth of upper jaw biserial, the inner

* Not verified in *Muræna argus*, which may belong to *aa*.

series of depressible canines; teeth on lower jaw and vomer uniserial; eye 2 to 2½ in snout, situated over the middle of gape; cleft of mouth 2¼ to 3 in head; head 2 to 2⅗ in trunk .... LENTIGINOSA, 37.

ee. Body scantily spotted; angle of mouth black; a large black spot about gill-opening; cleft of mouth 2¼ to 2¼ in head; head 2¼ to 2½ in trunk; tail a little longer than rest of body; teeth of upper jaw anteriorly in two rows; canines moderate; color dark brown, with many small obscure whitish spots, these sometimes over whole body, sometimes confined to head and back anteriorly; belly plain brown; dark spot on gill-opening and at angle of mouth always conspicuous; a pale spot on base of lower jaw before the dark one .... MELANOTIS, 38.

dd. Jaws curved along the gape so that they can not be completely closed; lateral teeth of upper jaw biserial, the teeth of the inner series longer than those of the outer; vomerine teeth uniserial; the anterior vomerine teeth longest, nearly twice as long as any of the others; mandibular teeth sometimes with two or three long teeth forming an inner mandibular series; cleft of mouth very wide, its width contained 2¼ in length of head; length of head 2½ in trunk; eye 2½ in snout; tail longer than rest of body; brownish black (in spirits); tail with numerous bluish-white dark-edged dots the size of a pin's head, disappearing on anterior part of body; inside of mouth brown with similar white dots. (*Günther.*)
AUGUSTI, 39.

33. MURÆNA HELENA.

(MORAY.)

Muræna pinnis pectoralibus carens Artedi, Genera Piscium, 25, 1738 (Rome and Livorno).
Muræna helena Linnæus, Syst. Nat., ed. X, 244, 1758 (based on Artedi); Günther, VIII, 96, and of authors generally.
Gymnothorax muræna Bloch & Schneider, Systema Ichthyol., 525, 1801 (after Linnæus).
Muræna romana Shaw, Gen. Zoöl., IV, 26, 1803 (after Linnæus).
Muræna variegata Rafinesque, Caratteri, etc., 67, 1810 (Sicily).
Murænophis fulva Risso, Ich. Nice, 367, 1810 (Nice).
Muræna guttata Risso, Eur. Mérid., III, 191, 1826 (Mediterranean Sea).

Habitat: Mediterranean Sea and adjacent shores.

Etymology: From Helena; the allusion not clear.

This species, the longest known of any in the family, is generally common in the waters of southern Europe. The specimens before us are from Palermo (Professor Doderlein), Madeira (Dr. W. Stimpson), Athens (Prof. H. A. Hoffman), and Naples (Prof. W. W. Norman).

34. MURÆNA INSULARUM.

Muræna insularum Jordan & Davis, sp. nov. (Chatham Island).

Habitat: Galapagos Archipelago.

Etymology: Latin, of the islands.

This species is based on No. 38300, U. S. National Museum, 20 inches long, collected by Dr. W. H. Jones at Chatham Island, of the Galapagos. The species resembles *M. helena*, but differs much in color.

35. MURÆNA ARGUS.

Gymnothorax (*Limamuræna*) *argus* Steindachner, Ich. Notizen, x, 17, tab. IV, 1870 (Altata, Mexico).

Habitat: Pacific Coast of Mexico.

Etymology: *Argus*, hundred-eyed, from the coloration.

This species is known to us from the description and figure of Steindachner.

36. MURÆNA RETIFERA.

Muræna retifera Goode & Bean, Proc. U. S. Nat. Mus., 435, 1882 (Charleston, S. C.); Jordan & Gilbert, Syn. F. N. A., 894, 1883 (Charleston); Jordan, Cat. F. N. A., 51, 1885 (Charleston).

Habitat: South Atlantic coast of United States.

Etymology: *Rete*, net; *fero*, I bear.

This species is known only from two or three large specimens obtained in the market at Charleston, South Carolina. The individual before us was sent by Mr. Charles C. Leslie.

37. MURÆNA LENTIGINOSA.

(MORENA PINTA; SPOTTED MORAY.)

Muræna lentiginosa Jenyns, Voy. Beagle, Zoöl., 143, 1842 (Galapagos Islands); Günther, VIII, 99, 1870 (Central America).

Muræna pinta Jordan & Gilbert, Proc. U. S. Nat. Mus., 277, 1881 (Amortajada Bay, San Josef Island (name only); Jordan & Gilbert, ibid, 345, 1881 (Mazatlan); Jordan & Gilbert, Proc. U. S. Nat. Mus., 371, 1882 (Colima); Jordan & Gilbert, ibid, 381 (Panama); Jordan, Bull. U. S. Fish Com., 106, 1882; Jordan, Proc. U. S. Nat. Mus., 369, 1885 (Mazatlan).

Habitat: Pacific coast of America from the Gulf of California to the Galapagos.

Etymology: *Lentiginosus*, freckled.

This species is rather common on the Pacific coast of tropical America. The specimen is from Colima. Another specimen, without locality, is much brighter in color with larger spots, but it apparently belongs to the same species. There is not much room for doubt that *lentiginosa* is identical with the common form later described as *pinta*.

38. MURÆNA MELANOTIS.

Limamuræna melanotis Kaup, Aale Hamb. Mus., 27, tab. 4, fig. 3, 1859 (*fide* Günther).

Muræna melanotis Günther, VIII, 98, 1870 (Cape Verde Islands; Pacific coast of Panama); Steindachner, Fische Afrikas, 33, 1881 (Gorea); Jordan & Gilbert, Proc. U. S. Nat. Mus., 624, 1882 (Panama); Jordan & Gilbert, Syn. F. N. A., 355, 1883 (copied); Jordan, Proc. U. S. Nat. Mus., 369, 1885.

Habitat: Tropical parts of the Atlantic.

Etymology: *Μέλας*, black; *ὄυς*, ear.

Of this species we have three specimens from "South America." A large specimen from Panama was identified by us in 1882 with this species, but without further comparison we do not feel sure of the identity of this individual with the original *melanotis* from the Atlantic.

39. MURÆNA AUGUSTI.

Muræna guttata (Banks & Solander MSS.) Lowe, Trans. Zool. Soc., II, 192 (Madeira); Richardson, Voy. Erebus and Terror, Fish., 90, 1842 (Madeira) (not of Risso, which is *Muræna helena;* nor of Forskål, which is a *Haliophis*).

Limamuræna guttata Kaup, Apodes, 96, 1856 (in part).

Thyrsoidea augusti Kaup, Apodes, 88, 1856 (Madeira) (after Richardson).

Muræna augusti Günther, VIII, 97 (Madeira); Vinciguerra, Pesci del Corsaro, 619 (Teneriffe).

Thyrsoidea atlantica Johnson, Proc. Zool. Soc. Lon., 168, 1860 (Madeira) (*fide* Günther).

Habitat: Islands of the Eastern Atlantic.

Etymology: A personal name.

This species is known to us only by the descriptions.

Genus 7.—ECHIDNA.

Echidna Forster, Enchiridion, 31, 1778 (*variegata*).

Gymnomuræna Lacépède, Hist. Nat. Poiss., v, 648, 1803 (*doliata=marmorata*).

Molarii Richardson, Voyage Erebus and Terror, 79, 1844 (*ophis=nebulosa*).

Pœcilophis Kaup, Apodes, 98, 1856.

Gymnomuræna Kaup, Apodes, 98, 1856 (*variegata=nebulosa*).

Type: *Echidna variegata* Forster.

Etymology: *Ἔχις*, viper.

This well-marked genus is distinguished from the other Morays by the blunt teeth. The name *Echidna* was suggested for this group of eels long before its application by Cuvier to a genus of Australian Monotremes. It must, therefore, be retained in preference to *Gymnomuræna*, *Molarii*, or *Pœcilophis*, and the mammalian genus should not be called *Echidna*.

There are some 12 or 15 species of *Echidna*, most of them belonging to the Western Pacific.

ANALYSIS OF THE AMERICAN SPECIES OF ECHIDNA.

a. Color dark, with small round yellow spots; teeth subequal, bluntish, less obtuse than in *E. catenata*, mostly uniserial; dorsal high, beginning over gill-opening; head short and blunt, the small eye half the snout; head 2¾ in trunk; cleft of mouth 3 in head; tail about a snout's length shorter than rest of body. Color, dark brown, with small round yellow spots, smaller than pupil, like pin points, scattered evenly and sparsely over the body; spots with blackish margins; lower jaw mottled.................................NOCTURNA, 40.

aa. Color brownish, marbled and barred with paler; head 3 to 3¼ in trunk, 3½ in tail; eye small, 1½ to 2 in snout; cleft of mouth 3 to 3½ in head; tail a trifle longer than rest of body; teeth of upper jaw more or less biserial. Color, brownish black, marbled or reticulated with light yellow or white, the light markings sometimes forming narrow irregular cross-bars; under the jaw and on the belly the light yellow often predominates, inclosing dark spots ......CATENATA, 41.

40. ECHIDNA NOCTURNA.

Pœcilophis nocturnus Cope, U. S. Geol. Surv. Mont. and Adj. Terr., 474, 1871 (Rio Grande, Costa Rica).

Habitat: Pacific Coast of Tropical America.

Etymology: Latin, nocturnal.

This species is known from the single specimen described by Professor Cope, and from a small specimen (43102, U. S. N. M.), of doubtful locality, supposed to have been taken by Mr. Xantus at Cape San Lucas. Cope says the anal fin is a little more than one-third the total length. This statement does not agree with our specimen.

41. ECHIDNA CATENATA.

Muræna seu conger brasiliensis Seba, Thesaurus, II, 72, tab. 69, fig. 4, 5, 1738 (*fide* Bleeker).
Gymnothorax catenatus Bloch, Ausl. Fische, XII, 74, tab. 415, fig. 1, 1795; Bloch & Schneider, 528, 1801 ("Coromandel").
Muræna catenata Richardson, Voy. Erebus and Terror, Fishes, 95, 1844 (*fide* Günther); Günther, VIII, 130, 1870 (Surinam, Puerto Cabello, Trinidad, Dominica, St. Croix, Barbadoes).
Pœcilophis catenatus Kaup, Apodes, 100, 1856 (Bermudas, Caribbean Sea).
Echidna catenata Bleeker, Ned. Tyds. Dierkunde, II, 242, 1865 (Surinam); Cope, Trans. Amer. Phil. Soc., 482, 1870 (St. Martin's); Poey, Enumeratio, 160, 1875; Goode, Bull. U. S. Nat. Mus., v, 73, 1876 (Bermuda); Jordan, Proc. U. S. Nat. Mus., 647, 1889 (St. Lucia).
Murænophis catenula Lacépède, Hist. Nat. Poiss., v, 628 and 641, 1803 (after Bloch).
Murænophis undulata Lacépède, Hist. Nat. Poiss., v, 629, tab. 19, f. 2, 1803.
Muræna sordida Cuvier, Règne Animal, ed. 1, 233, 1817 (based on Seba, LXIX, 4).
Muræna alusis Bleeker, Act. Soc. Sc. Ind. Neerl., 67, 1855 (*fide* Bleeker).
Echidna fuscomaculata Poey, Repertorio, II, 263, 1868 (Cuba); Poey, Synopsis, 428, 1868.
Echidna flavoscripta Poey, Repertorio, II, 264 (Cuba); Poey, Synopsis, 428, 1868.

Habitat: West Indian fauna.

Etymology: Latin, chained, from the markings.

This species is rather common in the West Indies and Caribbean Sea. The specimens before us are from Port Castries, St. Lucia.

Family II.—OPHISURIDÆ.

(THE SNAKE EELS.)

We adopt for the present the family *Ophisuridæ*, in the sense in which (under the name *Ophisuroidei*) it is defined by Bleeker. It includes those Enchelycephalous eels which are scaleless, and have the end of the tail projecting beyond the dorsal and anal fins and without even the rudiment of a caudal fin. The anterior nostrils are placed in the upper lip, opening downwards, the gill-openings are not confluent, and the tongue is more or less fully adnate to the floor of the mouth. The species are, for the most part, moderate or small in size, and they are very abundant in the tropical seas, especially about the coral reefs. The eggs are numerous, of moderate size, similar to those of ordinary fishes. Most of the known genera are found in America, but less than half the species. Many of the species are singularly colored, the bands or spots heightening the analogy between them and the serpents.

ANALYSIS OF THE AMERICAN AND EUROPEAN GENERA OF OPHISURIDÆ.

a. Body without traces of fins anywhere; teeth all small, conical; gill-openings near together, subinferior; anterior nostril tubular; tongue scarcely free in front; mouth small.............SPHAGEBRANCHUS, 8.

aa. Body with distinct fins, at least on the back.

b. Anal fin wholly wanting; no pectoral fin; dorsal fin high, beginning on the head; gill-openings subinferior, converging; anterior nostrils tubular; tongue slender, somewhat free in front.
LETHARCHUS, 9.

bb. Anal fin well developed; anterior nostril usually in a short tube near tip of snout.

c. Teeth blunt, mostly granular or molar; vomer with teeth; pectoral fins present, small.

d. Dorsal fin rather high, beginning on the head, before the gill-opening.
MYRICHTHYS, 10.

dd. Dorsal fin low, beginning well behind the head ....[PISOODONOPHIS.]

cc. Teeth all pointed, none of them molar; vomer with teeth.

e. Dorsal fin beginning before nape, on anterior part of head; pectoral fin small or wanting.

f. Pectoral fins wholly wanting; body compressed, the dorsal fin high.
CALLECHELYS, 11.

ff. Pectoral fins small, but present; body elongate, subterete, the dorsal fin moderate..............................BASCANICHTHYS, 12.

ee. Dorsal fin beginning more or less behind the gill-opening.

g. Pectoral fins wholly wanting; gill-openings inferior, transverse, close together; mouth small, with small subequal teeth.
CÆCULA, 13.

gg. Pectoral fins reduced to a small flap, not longer than eye; teeth small, mostly uniserial; gill-openings lateral.
QUASSIREMUS, 14.

ggg. Pectoral fins well developed, much longer than eye; gill-openings usually lateral, sometimes subinferior.

h. Snout moderate or short, less than one-fourth head, the jaws not produced into a slender beak.

i. Lips not fringed.

j. Teeth subequal, with no elongate canines on jaws or vomer.
OPHICHTHUS, 15.

jj. Teeth unequal, some of them long canines, either on vomer or on sides of one or both jaws; mouth large, the snout short, and the eyes more or less superior........MYSTRIOPHIS, 16.

ii. Lips with a conspicuous fringe of papillæ; canines present; jaws rather long; head depressed; eyes superior; lower jaw projecting..............................BRACHYSOMOPHIS, 17.

hh. Snout very long, attenuate, clavate at tip, its length more than one-fourth head; jaws slender and elongate; canine teeth strong; tail much longer than trunk; head compressed, the eyes lateral ....OPHISURUS, 18.

Genus 8.—SPHAGEBRANCHUS.

Sphagebranchus Bloch, Ichthyologia, IX, 88, pl. 419, 1795 (*rostratus*).

Cæcilia Lacépède, Hist. Nat. Poiss., II, 135, 1800 (*branderiana=cæcus*); (not *Cæcilia* L., a genus of Batrachia).

Aptérichthe Duméril, Zoölogie Analytique, 1806 (*cæcus*).

Apterichthys De la Roche, Ann. Mus., XIII, 325, 1809 (*cæcus*).
Ichthyapus Brisout de Barneville, Revue Zoölogique, 219, 1847 (*acutirostris*).
Ophisuraphis Kaup, Apodes, 29, 1856 (*gracilis*).

Type: *Sphagebranchus rostratus* Bloch.

Etymology: *Σφάξ*, throat; *βράγχια*, gills,

This genus contains several little-known species of small eels remarkable for showing no trace of fins in the adult stage. The name *Sphagebranchus* is based on a species which evidently belongs to the genus, and has, therefore, clear priority over *Ichthyapus* and *Apterichthys.*

ANALYSIS OF THE SPECIES OF SPHAGEBRANCHUS.

a. [Eyes invisible; tail longer than rest of body; body very slender; mouth small; snout pointed, depressed; uniform brown, speckled with black on the head.] (*Risso*) .... CÆCUS, 42.

aa. Eyes externally visible.

b. Tail nearly one-half longer than head and trunk.

c. [Head 6 in trunk, 17 in total length; flesh-colored with small black spots.] (*Peters*) .... ANGUIFORMIS, 43.

cc. Head a little more than 4 times in trunk; tail sharp-pointed; snout sharp; cleft of mouth $2\frac{1}{4}$ to 3 in head; gill-slits almost horizontal, converging forwards, the isthmus equal to eye, which is 2 in snout. General color light brown, slightly dusky on the back and more dusky along the lateral line; head mottled with dusky spots .... SELACHOPS, 44.

bb. Tail but little longer than head and trunk.

d. Head more than $\frac{1}{5}$ length of trunk.

e. [Head $4\frac{1}{2}$ in trunk, $11\frac{1}{2}$ in total length; eye over middle of jaw; body slender; tail rounded, a little longer than head and trunk; anterior nostril on lower side of snout, its border denticulate.] (*Günther.*) ACUTIROSTRIS, 45.

ee. [Head about 2 in trunk, 5 in total length; snout very sharp; eye moderate, over middle of gape; tail scarcely as long as rest of body; color plain brown.] (From Bloch's figure.) .... ROSTRATUS, 46.

dd. Head less than $\frac{1}{5}$ of trunk, contained $7\frac{3}{4}$ in trunk, $9\frac{3}{4}$ in tail; snout sharp; cleft of mouth 4 in head; gill-slits small, inferior, directly transverse as in *Cæcula imberbis*, the isthmus very narrow, not as wide as eye, which is 2 in snout; tail sharp-pointed; eye before middle of gape; plain-brownish, speckled .... KENDALLI, 47.

42. SPHAGEBRANCHUS CÆCUS.

Muræna cæca Linnæus, Syst. Nat., x, 245, 1758 (Mediterranean Sea).
Sphagebranchus cæcus Bloch & Schneider, Syst. Ich., 535, 1801 (and of various authors).
Apterichthys cæcus De la Roche, Ann. Mus., XIII, 325, 1809 (*fide* Günther).
Ophichthys cæcus, Günther, VIII, 89, 1870 (copied).
Cæcula apterygia Vahl, Skrivter af Naturh. Selskabet, 1794, 150 (after Linnæus).
Cæcilia branderiana Lacépède, Hist. Nat. Poiss., II, 135, 1800 (after Linnaeus).
Sphagebranchus spallanzanii Costa, Fauna Nap., Pesc., tav. 32, f. 1 (*fide* Günther).

Habitat: Mediterranean Sea.

Etymology: *Cæcus*, blind.

This species is known to us from descriptions only.

43. SPHAGEBRANCHUS ANGUIFORMIS.

Ophichthys (Sphagebranchus) anguiformis Peters, Monat. Kön. Akad. Wiss., 849, 1876 (open Atlantic).

Habitat: Atlantic Ocean, 15° 40′ 1″ N., 23° 5′ 8″ W.

Etymology: *Anguis*, the slow-worm; from Latin, *anguis*, snake.

This doubtful species is known only from the account given by Peters. It is very likely identical with *S. acutirostris*.

44. SPHAGEBRANCHUS SELACHOPS.

Apterichthys selachops Jordan & Gilbert, Proc. U. S. Nat. Mus., 356, 1882 (Cape San Lucas).

Ichthyapus selachops Jordan, Proc. U. S. Nat. Mus., 369, 1885; Jordan, Cat. Fish. N. A., 52, 1885.

Habitat: Cape San Lucas.

Etymology: *Σελαχή*, shark; *ὄψ*, face.

This species is thus far known from the rocks about Cape San Lucas. Two specimens lately obtained by Dr. Gilbert in that locality are before us.

45. SPHAGEBRANCHUS ACUTIROSTRIS.

? *Sphagebranchus rostratus* Bloch, Ichth., IX, 88, tab. 419, f. 2, 1795 (Surinam).

Ichthyapus acutirostris Barneville, Rev. Zoöl. 219, 1847 (open Atlantic); Kaup, Apodes, 29, 1856 (copied).

Ophichthys acutirostris Günther, VIII, 90, 1870 (copied).

Habitat: Open sea under the equator.

Etymology: *Acutus*, sharp; *rostrum*, snout.

This species is known only from a single specimen taken in the open Atlantic. This is very likely the same as the poorly figured *Sphagebranchus rostratus* of Bloch.

46. SPHAGEBRANCHUS ROSTRATUS.

Sphagebranchus rostratus Bloch, Ichthyologia, IX, 88, pl. 419 (Surinam); Bloch & Schneider, Syst. Ichth., 535, tab. 103, 1801 (copied).

Habitat: West Indian Fauna.

Etymology: *Rostratus*, long-nosed.

This species is known only from the description and figure of Bloch. It is perhaps the same as *S. acutirostris* of Barneville.

47. SPHAGEBRANCHUS KENDALLI.

Sphagebranchus kendalli Gilbert, Proc. U. S. Nat. Mus., 1891 (coast of Florida).

Habitat: Gulf of Mexico.

Etymology: Named for Mr. Kendall, who obtained the species.

This species is known from one specimen 7 inches long, dredged by the U. S. Fish Commission schooner *Grampus*, at station 5080, off the coast of Florida. It is well distinguished from *S. selachops* (the only

other species in the genus which has been fully described) by the transverse gill-openings.

Genus 9.—LETHARCHUS.

Letharohus Goode & Bean, Proc. U. S. Nat. Mus., 437, 1882 (*velifer*).

Type: *Letharchus velifer* Goode & Bean.

Etymology: *Λήθομαι*, to forget; *ἀρχός*, anal.

This well-marked genus is represented by a single species, found in the Gulf of Mexico.

ANALYSIS OF THE SPECIES OF LETHARCHUS.

a. Teeth uniserial on jaws and vomer, small and directed inward and backward; snout long and pointed, projecting two-thirds its length beyond the lower jaw; gill-openings subinferior, almost horizontal, equal to lower jaw, three times the breadth of the isthmus; nostrils not prominent, without tube; anterior under the tip of snout; lateral line distinct, extending forward in a curve, ending in a pore on the top of head, just in front of the beginning of the dorsal fin; head $1\frac{1}{2}$ in trunk; tail pointed, $1\frac{1}{2}$ in total length; cleft of mouth 4 in head; snout 9 in head and twice the diameter of the eye. Plum-colored, head lighter, throat pale; dorsal fin white, edged with a broad band of black................VELIFER, 48.

48. LETHARCHUS VELIFER.

Letharchus velifer Goode & Bean, Proc. U. S. Nat. Mus., 437, 1882 (West Florida). Jordan & Gilbert, Syn. F. N. A., 896, 1883 (copied); Jordan, Proc. U. S. Nat. Mus., 33, 1884 (Pensacola).

Habitat: West coast of Florida.

Etymology: *Velum*, sail; *fero*, I bear.

Several specimens of this species have been obtained, all of them from the Snapper Banks between Pensacola and Tampa. The specimen before us was brought from Pensacola by Dr. Jordan.

Genus 10.—MYRICHTHYS.

Pisoodonophis Kaup, Apodes, 15, 1856 (in part; not type, as restricted by Bleeker, which is *P. cancrivorus*).

Myrichthys Girard, Proc. Acad. Nat. Sci. Phila., 1859, 58 (*tigrinus*).

Ophisurus Swainson, Bleeker, Jordan & Gilbert, etc., not of Lacépède, nor of Risso nor Kaup, who restrict the name to *O. serpens*.

Type: *Myrichthys tigrinus* Girard.

Etymology: *Μῦρος*, Myrus; *ἰχθύς*, fish.

This genus contains numerous species, some of which are found in most tropical seas. It is well distinguished from *Ophichthus* by its blunt teeth, bearing the same relation to *Ophichthus* that *Echidna* does to *Gymnothorax*. The Old World genus *Pisoodonophis* has also molar teeth, but in that group the dorsal is inserted much farther back, behind the gill-openings, as in *Ophichthus*.

We adopt for this genus the name *Myrichthys*, instead of *Ophisurus*, because the name *Ophisurus* was originally given to two species, neither

of which belongs to the present genus, and because it had been properly restricted to *O. serpens* before it was connected with the present group. The confusion arose from the supposition of Cuvier that *Ophisurus ophis* Lacépède was an eel with blunt teeth, unlike the *ophis* of Linnæus.

A careful comparison of specimens of *Ophichthus xysturus* with the original description of *Myrichthys tigrinus* leaves no doubt of the identity of the two species. We have furthermore before us a specimen (8810) from the National Museum, of which the record has been lost, but evidently going back to Girard's time. This specimen is undoubtedly the original type of *Myrichthys tigrinus*, and agrees fully with *Ophichthus xysturus*.

ANALYSIS OF AMERICAN SPECIES OF MYRICHTHYS.

a. Spots on body large, blackish, without pale centers.

b. Spots on anterior part of body near lateral line oblong, those on head rather large; dorsal with dark spots; anal immaculate; dark spots on sides in 3 or 4 rows; a row of 3 spots from gill-opening to above eye; 4 spots in a series below this; 3 to 5 spots on each side of snout; lower jaw with 3 large spots; head 4 in trunk; cleft of mouth 3 in head. (*Valenciennes.*)......PARDALIS, 49.

bb. Spots on sides of body all circular or nearly so; those on anterior part of head small and numerous; general color brown, lighter below; belly almost plain; 4 longitudinal rows of round black blotches on each side of body, the two middle series often forming one irregular row, the central row very close to the median and consisting of small spots not much larger than the eye, spots in the uppermost row often running up on the dorsal fin, each dorsal row running forward terminating in the snout; 8 or 9 spots in each dorsal row from the tip of snout to vertical from gill-opening; a row of 5 to 6 spots from gill-opening to above eye; two other rows running diagonally downwards and backwards from the eye; 7 to 8 spots on each side of snout; jaw with about a dozen spots on each side; dorsal with dark margin; anal plain. Head $3\frac{1}{2}$ in trunk, 11 in total length; eye $2\frac{1}{2}$ in snout, situated a little back of middle of gape, which is 3 in the head; snout $5\frac{1}{2}$ in head; pectoral, measured from top of base, about equal to eye ....TIGRINUS, 50.

aa. Spots on body large, dark, most of them with a distinct pale center. Body dark gray above, white below; on each side two series of large roundish dark spots, with pale centers, one row lying along the dorsal fin, the other a little below the lateral line; about 35 spots in each row; a large spot in front of dorsal fin; snout with about 5 spots on each side; lower jaw with small dusky spots; dorsal fin with a dusky edge and with faint dusky blotches; anal plain. Eye 2 in snout; snout 6 in head, and 4 in the distance from the tip of the snout to the beginning of the dorsal fin; cleft of mouth $3\frac{1}{2}$ in head; head 4 in the trunk, and a little more than 8 in the tail ....OCULATUS, 51.

aaa. Spots on body large, nearly round, and whitish in color; ground color dark brown, pale below; two series of round whitish blotches on each side of body, about 40 spots in each series; spots somewhat larger and more distinct anteriorly, where their diameter is nearly equal to the length of snout; head with irregular, round, whitish spots on each side; dorsal brownish, margined with dusky; other fins pale. Snout $5\frac{2}{3}$ in head and twice the diameter of the eye; cleft of mouth 3 in head; head 4 in trunk; head and trunk $1\frac{2}{3}$ in tail; dorsal beginning at a point slightly nearer the base of pectorals than eye; body extremely elongate, the diameter about $\frac{1}{3}$ length of head....ACUMINATUS, 52.

49. MYRICHTHYS PARDALIS.

Ophisurus pardalis Valenciennes, in Webb & Berthelot, Îles Canaries, Poiss., 90, pl. 16, fig. 2, 1836–1844; Richardson, Erebus and Terror, Fishes, 99, 1844 (not of Günther).
? *Ophisurus breviceps* Richardson, Voy. Ereb. and Terror, 99, 1844–1848 (locality unknown); (not of Cantor, 1850).
? *Pisoodonophis breviceps* Kaup, Apodes, 20, 1856 (same type).
? *Ophichthys breviceps* Günther, VIII, 82, 1870 (same type).
Pisoodonophis coronata Kaup, Aale Hamb. Mus., 14, tab. 2, fig. 1, 1859 (*fide* Günther).

Habitat: Tropical parts of the Atlantic.

Etymology: Latin, marked like a leopard.

We know this species only from the description of Valenciennes. We have ventured to refer to the Atlantic *pardalis*, the descriptions of *M. breviceps*. They agree equally well with *pardalis* and *tigrinus*, and the specimen from an unknown locality named *breviceps* by Richardson is at least as likely to have come from the Atlantic as the Pacific Ocean. Possibly *pardalis* and *tigrinus* may prove to be identical, but the markings of *tigrinus* differ from those shown in Valenciennes' figure.

50. MYRICHTHYS TIGRINUS.

? ? *Ophisurus breviceps* Richardson, Voyage Erebus and Terror, Fishes, 99, 1844 (locality unknown).
Myrichthys tigrinus Girard, Proc. Acad. Nat. Sci. Phila., 58, 1859 ("Adair Bay, Oregon").
Ophisurus xysturus Jordan & Gilbert, Proc. U. S. Nat. Mus., 346, 1881 (Mazatlan).
Pisoodonophis xysturus Jordan, Bull. U. S. Fish Comm., 106, 1882 (Mazatlan).

Habitat: Pacific coast of Tropical America.

Etymology: Latin, like a tiger (in color).

This species is rather common on the west coast of Mexico. We have adopted the name *tigrinus* instead of *xysturus*, as there seems to be no doubt that Girard's type, said to be from "Adair Bay, Oregon," belongs to this tropical species. This locality is, however, very doubtful, and probably Girard's specimen came from the coast of Mexico. A specimen before us from the old collections of the Museum is, as already stated, probably Girard's original type. It may be that Richardson's *breviceps* is also identical with *xysturus*, but it is on the whole more likely to be the Atlantic species *pardalis*. Besides the types of *M. tigrinus* and *M. xysturus*, we have before us a specimen taken by Dr. Gilbert in the Gulf of California.

51. MYRICHTHYS OCULATUS.

Pisoodonophis oculatus Kaup, Apodes, 22, 1856 (Curaçoa).
Ophisurus latimaculatus Poey, Repertorio, II, 252, tab. 3, fig. 1, 1867 (Cuba); Poey, Synopsis, 425, 1868.
Pisoodonophis latimaculatus Cope, Trans. Amer. Phil. Soc., 482, 1870 (St. Martin's); Poey, Enumeratio, 153, 1875.
Ophichthys latimaculatus Poey, Anal. Soc. Esp. Hist. Nat., 252, 1880; Poey, Ann. Soc. Esp. Hist. Nat., 345, 1881 (Porto Rico).

Ophichthys pardalis Günther, VIII, 82, 1870 (Lanzarote, Canary Islands, Cape Verde Islands, West Indies); (not *Ophisurus pardalis* Valenciennes.)

Habitat: West Indies and islands of eastern Atlantic.

Etymology: Latin, having eye-like markings.

This species, generally distributed through the tropical Atlantic, is well distinguished by its coloration, most of the dark spots having conspicuous white centers. This is undoubtedly the *oculatus* of Kaup and the *latimaculatus* of Poey, but the *pardalis* of Valenciennes must be different, being similar in coloration to *tigrinus*. The specimen before us is from Barbadoes.

52. MYRICHTHYS ACUMINATUS.

Muræna acuminata Gronow, Fishes Brit. Mus., 21, 1854 ("In Insula Divi Eustachii in America").
Ophichthys acuminatus Günther, VIII, 83, 1870 (Cuba, Barbadoes).
Ophisurus acuminatus Jordan, Cat. Fish. N. A., 53, 1885.
Pisoodonophis guttulatus Kaup, Apodes, 21, fig. 10, 1857 (Martinique).
Ophisurus longus Poey, Repertorio, II, 254, 1867 (Cuba); Poey, Synopsis, 425, 1868.
Ophisurus longus Poey, Anal. Soc. Esp. Hist. Nat., 253, 1880.
Pisoodonophis longus Jordan & Gilbert, Syn. F. N. A., 899, 1883 (Florida).
Ophichthys pisavarius Poey, Anal. Soc. Esp. Hist. Nat., 196, 1875 (Cuba); Poey, l. c., 253, 1880.

Habitat: West Indian fauna, north to Florida Keys.

Etymology: Latin, acuminate.

This species, well distinguished by its pale spots, is not rare in the West Indies. Our description is taken from a specimen in the National Museum from the Florida Keys.

The name *acuminatus* seems to belong to this species, and has priority over *longus*.

We have referred the nominal species, *longus*, *guttulatus*, and *pisavarius* to the synonymy of *acuminatus*, thinking that the alleged differences are matters of individual variation. *Longus* is said to have, in the center of each pale spot, a yellow speck, surrounded by a dark circle. The others are said to lack this central spot, but it may be that it fades in alcohol. *Longus* is said to have the edge of the dorsal darker than the fin. In *guttulatus* and *pisavarius* it is said to be paler.

Genus PISOODONOPHIS.

Pisoodonophis Kaup, Apodal Fishes, 1854, 17 (*boro*).
Pisodontophis, Günther, VIII, 55, 1870 (*boro*: corrected orthography).

Type: *Ophisurus boro* Hamilton-Buchanan.

Etymology: *Πίσον*, pea; ὀδών, tooth; ὄφις, snake.

Small eels, mostly of the Old World, intermediate between *Myrichthys* and *Ophichthus*, having the blunt teeth of *Myrichthys* and the backward dorsal of *Ophichthus*. The species are slender, plainly colored, and rather small. One of them is doubtfully recorded from the West Indies.

PISOODONOPHIS Species.

Dr. Günther (VIII, 78) mentions a half-grown eel from Grenada, West Indies, which he regards as closely allied to *Pisoodonophis boro* of the Chinese and East Indian seas. "At present I do not think myself justified in separating this single specimen from *P. boro*, which varies rather considerably in the relative proportion of the parts of the body." If the specimen really came from the West Indies, it will be probably found to be different from *P. boro.*

Of *P. boro* we have one specimen from Swatow, China. The species has the head contained about four times in the very long trunk, and the vertical fins are very low. Color, plain brown.

Genus 11.—CALLECHELYS.

Callechelys Kaup, Apodes, 28, 1856 (*guichenoti*).

Type: *Callechelys guichenoti* Kaup.

Etymology: *Καλός*, beautiful; *ἔγχελυς*, eel.

This genus contains one American and three East Indian species, agreeing in the elongate, compressed body, absence of pectoral fins, and anterior insertion of the dorsal. In other respects *Callechelys* is close to *Ophichthus.*

The American species, *Callechelys murœna*, considerably resembles the East Indian *marmoratus* and may be considered as a typical *Callechelys.* The other American species hitherto referred to *Callechelys* diverge widely from this type and should apparently constitute a distinct genus, which we have called *Bascanichthys*, though in the development of the pectorals one of these (*scuticaris*) is distinctly intermediate.

ANALYSIS OF THE AMERICAN SPECIES OF CALLECHELYS.

a. Depth of body at gill-openings a little more than length of upper jaw, which is 3 in head; head 8 in trunk, about 14 in total length; eye small, 2 in snout, placed over the middle of upper jaw; tip of lower jaw extending a little before the front of eye; gill-openings small, inferior, sublongitudinal, the distance between them about half the height of one of them; dorsal fin beginning on the head, at a distance behind the angle of the mouth, a little more than half the length of upper jaw. Dark olive, closely mottled and spotted with confluent blotches of darker olive and blackish, the spots more distinct anteriorly, posteriorly confluent, so that the tail is nearly plain dusky; belly scarcely paler, dorsal and anal chiefly blackish with pale margins...MURÆNA, 53.

53. CALLECHELYS MURÆNA.

Callechelys murœna Jordan & Evermann, Proc. U. S. Nat. Mus., 466, 1886 (Snapper Banks off Pensacola, Fla.).

Habitat: Deep waters of the Gulf of Mexico.

Etymology: *Murœna*, from the general resemblance of the species to a young Moray.

This species is known from a single specimen taken at the Snapper

Banks near Pensacola. It considerably resembles the East Indian *Callechelys marmoratus*.

Genus 12.—BASCANICHTHYS.

Bascanichthys Jordan & Davis, gen. nov. (*Bascanium*).

Type: *Cœcula bascanium* Jordan.

Etymology: *Bascanion*, the black snake, from *βασκανός*, malignant; *ἰχθύς*, fish.

This genus is very close to *Callechelys*, from which it differs in the presence of pectorals, the long subterete body, lower fins and plain coloration. Two species are known.

ANALYSIS OF SPECIES OF BASCANICHTHYS.

a. Pectoral fin a slender rudiment about as long as eye; head moderate; body terete, the trunk a little longer than the tail; teeth short, bluntish, recurved, uniserial * in each jaw, biserial on vomer; head $8\frac{3}{5}$ to $9\frac{3}{5}$ in head and trunk, 8 in tail; snout 6 to 7 in head; eye 2 in snout, a little behind the middle of cleft, which is contained in the head $3\frac{3}{5}$ times; lower jaw extending forward to middle of snout; distance from tip of snout to beginning of dorsal contained a little over two times in head; gill-openings vertical, their length about equal to breadth of isthmus; lateral line curved over the opercular region, the pores distant and well separated. Color brown above, lighter below, front of head more or less mottled; dorsal and anal fins pale without dark margins.................................SCUTICARIS, 54.

aa. Pectoral fins moderately developed, broader than long, nearly as long as snout; head very short; body extremely slender, subterete, its greatest depth little more than two-fifths of head; head short, $11\frac{1}{2}$ in head and trunk; $22\frac{1}{2}$ in total length; eye more than half the length of snout, placed over the middle of upper jaw; lower jaw thin, included, not extending to the anterior nostril; snout 7 in head; gill-opening as wide as isthmus; dorsal fin very low, beginning midway between front of eye and gill-openings. Color dark brown, nearly uniform, fins paler. BASCANIUM, 55.

54. BASCANICHTHYS SCUTICARIS.

Sphagebranchus scuticaris Goode & Bean, Proc. U. S. Nat. Mus., 343, 1879 (Cedar Key, Fla.).

Cœcula scuticaris Jordan & Gilbert, Syn. Fish. N. A., 358, 1883; Jordan, Proc. Acad. Nat. Sci. Phila., 42, 1884 (Egmont Key, Fla.).

Sphagebranchus teres Goode & Bean, Proc. U. S. Nat. Mus., 436, 1882 (West Florida).

Cœcula teres Jordan & Gilbert, Syn. Fish. N. A., 897, 1883 (West Florida).

Habitat: West coast of Florida from Pensacola to Egmont Key.

Etymology: Latin, *scutica*, a whip.

This species is not rare in the Gulf of Mexico; the specimens examined by us are from Egmont Key, Punta Rassa, and Pensacola.

We have no doubt that the two nominal species, *scuticaris* and *teres*, are identical, as our specimens sufficiently agree with both descriptions.

55. BASCANICHTHYS BASCANIUM.

Cœcula bascanium Jordan, Proc. Acad. Nat. Sci. Phila., 43, 1884 (Egmont Key, Fla.).

Callechelys bascanium Jordan, Cat. Fish. N. A., 52, 1885.

Habitat: Gulf of Mexico.

---

* Teeth biserial on one side of upper jaw in one specimen.

Etymology: *Bascanion*, the black snake, from βασκανός, malignant.

This species is known only from the original type, taken at Egmont Key. In its short head and developed pectoral it differs sufficiently from *Bascanichthys scuticaris*.

Genus 13.—CÆCULA.

Cæcula Vahl, Skrivter af Naturhistorie-Selskabet, 3d Band, 149, 1794 (*pterygera*).
Dalophis Rafinesque, Caratteri, 69, 1810 (*serpa; bimaculata*).
? **Pterurus** Rafinesque, Indice, 59 (*flexuosus*) (name preoccupied).
Lamnostoma Kaup, Apodes 23, 1856 (*pictus*).
Anguisurus Kaup, l. c., 24 (*punctulatus*).

Type: *Cæcula pterygera* Vahl.

Etymology: A diminutive, from *cæcus*, blind.

This genus contains several species all belonging to the Old World. It is allied to *Sphagebranchus*, differing in the possession of more or less developed fins. It is even closer to *Ophichthus*, from which the absence of pectorals separates it, leaving the group called *Quassiremus* intermediate. The name *Cæcula* has clear priority over *Dalophis*.

ANALYSIS OF THE EUROPEAN SPECIES OF CÆCULA.

a Pectoral minute or wholly wanting: body slender, terete; mouth rather small; jaws weak; eye very small; teeth uniserial in jaws and on vomer; gill-slits vertical, the slit a little longer than the isthmus; dorsal fin inserted about a head's length behind the gill-openings; head 6 in trunk, 7⅗ in tail; cleft of mouth 4½ in head; eye 3 in snout, the anterior edge over middle of gape; snout 6⅗ in head, interorbital width equal to isthmus. Color (in spirits) plain pinkish-brown,* lighter below .... IMBERBIS, 56.

56. CÆCULA IMBERBIS.

Sphagebranchus imberbis De la Roche, Ann. Mus., XIII, 360, pl. 25, fig. 17, 1809 (*fide* Günther); Kaup, Apodes, 25, 1856 (Toulon).
Ophichthys imberbis Günther, VIII, 84, 1870 (Sicily; Nice; Algiers).
Leptocephalus spallanzani Risso, Ichth. Nice, 85, 1810 (Eza).
Dalophis bimaculata Rafinesque, Caratteri, 69, tab. 7, fig. 2, 1810 (Sicily).
Dalophis serpa Rafinesque, Caratteri, 69, tab. 7, fig. 3, 1810 (Palermo).
? *Pterurus flexuosus* Rafinesque, Indice, 59, 1810 (Palermo).
Sphagebranchus oculatus Risso, Eur. Mer., III, 196, 1826 (Mediterranean Sea).

Habitat: Mediterranean Sea.

Etymology: Latin, without barbel.

Of this species we have a single large example, about 16 inches long, obtained at Naples by Prof. William W. Norman.

Genus 14.—QUASSIREMUS.

Quassiremus Jordan & Davis, gen. nov. (*evionthas*).

Type: *Ophichthus evionthas* Jordan & Bollman.

* According to the Risso, the life color is as follows: "Pink, the back with very small black spots, sides with curved whitish streaks, belly yellowish red."

Etymology: Latin, *quassus*, obliterated; *remus*, oar, from the minute pectorals.

This new generic name is proposed for two species, *nothochir* and *evionthas*, which agree with *Ophichthus* in all respects except that the pectoral fins are rudimentary.

ANALYSIS OF THE SPECIES OF QUASSIREMUS.

a. [Body marked with rather large yellow spots, each with a black ring, and with black spots and blotches of various sizes; pectorals minute, less than ⅓ of eye. Teeth all uniserial; pectorals represented by a small triangular flap, less than ⅓ the diameter of eye and ¼ the gill-slit; head 4⅓ in trunk; head and trunk longer than tail by a distance equal to the length of the snout; cleft of mouth 2¼ in head; snout 4 in head; eye ½ of snout, its anterior margin over middle of cleft of mouth; gill-slit vertical, lateral, 6½ in head. Middle of back with a series of 12 elliptical yellow spots, their length one-half time the diameter of the eye, each spot surrounded by a black ring, coalescent below with a large elliptical black blotch on middle of sides; head closely covered with spots about the size of the eye, around which are reticulations of light yellow.] (*Gilbert.*)..NOTHOCHIR, 57.

aa. Body everywhere freckled with small black spots; pectorals very small, about as long as eye; teeth in jaws uniserial, anterior vomerine teeth biserial; head 4¾ in trunk; snout 4½ in head; eye 2⅗ in snout, much nearer angle of mouth than tip of snout; cleft of mouth 2⅗ in head. Color light olive, the entire body covered with small numerous round or oval black spots separated at intervals by a yellowish ground color; in about fifteen places these spots are larger and darker and tend to form cross-bands ....EVIONTHAS, 58.

57. QUASSIREMUS NOTHOCHIR.

Ophichthys nothochir Gilbert, Proc. U. S. Nat. Mus., 58, 1890 (San Josef Island).

Habitat: Gulf of California.

Etymology: Νοθός, spurious; χείρ, hand, from the minute pectorals.

This species is known from three specimens taken by Dr. Gilbert at San Josef Island in the Gulf of California.

58. QUASSIREMUS EVIONTHAS.

Ophichthus evionthas Jordan & Bollman, Proc. U. S. Nat. Mus., 154, 1889 (Hood Island, Galapagos).

Habitat: Galapagos Archipelago.

Etymology: Ἐυ, well; ἴονθας, freckled.

This species is known from a single specimen obtained by the *Albatross* from Hood Island in the Galapagos.

Genus 15.—OPHICHTHUS.

Ophichthus Thunberg & Ahl, De Muræna et Ophichtho, 1789 (*ophis*).

Ophisurus Lacépède, Hist. Nat. Poiss, II, 1800 (*ophis; serpens;* not of Risso).

Cogrus Rafinesque, Caratteri, etc., 62, 1810 (*maculatus*).

Ophisurus Swainson, Nat. Hist. Classn. Anim., 334, 1839 (*pictus* = *remicaudus*). (Not of Lacépède.)

Centrurophis Kaup, Apodes, 2, 1856 (*spadiceus*).

Pœcilocephalus Kaup, l. c., 5 (*bonapartei*).

Microdonophis Kaup, l. c., 6 (*altipinnis*).

Cœcilophis Kaup, l. c., 6 (*compar*).

Herpetoichthys Kaup, l. c., 7 (*ornatissimus*).
Elapsopsis Kaup, l. c., 9 (*versicolor*).
Muraenopsis* ("Le Sueur") Kaup, l. c., 11 (*ocellatus*).
Scytalophis Kaup, l. c., 13 (*magnioculis*).
Leptorhinophis Kaup, l. c., 14 (*gomesi*.)
Cryptopterus Kaup, Aale Hamburg. Museum, 1859 (*puncticeps*).
Uranichthys Poey, Rep. Fis. Nat. Cuba, II, 256, 1867 (*havannensis*).
Oxyodontichthys Poey, Anales Soc. Nat. Hist. Esp., 254, 1880 (*macrurus*).
Ophichthys Bleeker, Günther, and of recent authors generally.

Type: *Muræna ophis* L.

Etymology: Ὄφις, snake; ἰχθύς, fish; hence more correctly written *Ophichthys.*

We adopt the genus *Ophichthus*, in the same sense as the *Ophichthys* of Bleeker, for those Ophisuroid eels which have sharp teeth, no marked canines, well-developed pectoral fins, and the dorsal inserted behind the head. The species are very numerous in the tropical seas, and many attempts have been made to split the group into smaller genera. Notwithstanding the great differences when extremes are compared, these small genera do not seem well defined. We adopt the original spelling, *Ophichthus*, though *Ophichthys* is the more correct form of the word.

ANALYSIS OF AMERICAN AND EUROPEAN SPECIES OF OPHICHTHUS.

a. Teeth of upper jaw uniserial; end of tail more or less sharp (*Cogrus* Rafinesque).

b. Tail very slender, more than twice as long as rest of body. Pectoral fin rather small, contained 3 to 5 times in the length of head; body very long and slender; head small, the gape narrow and the jaws very weak; teeth in jaws uniserial, on vomer biserial, some of the front teeth above very slightly enlarged; gill-openings lateral, vertical, about equal to isthmus; dorsal fin beginning about half the length of the head behind the base of the pectorals; head 4½ in trunk; head and trunk 2½ in tail; cleft of mouth 4 in head; eye 2 in snout, anterior edge about over middle of gape; pectoral fin 4 in head. Uniform brown above, lighter below; fins light brown.... HISPANUS, 59.

bb. Tail not twice as long as rest of body.

c. [Pectoral fin short, about one-fourth head; head 4½ in trunk; gape 3 in head; teeth all uniserial; dorsal beginning at some distance behind pectorals. Color yellowish brown with black dots.] (*Kaup*.)..... BRASILIENSIS, 60.

cc. [Pectoral fin long, about 2⅕ in head; dorsal commencing at a moderate distance from tip of pectoral; head 4 in trunk; tail rather longer than rest of body; dorsal and anal fin with whitish or brownish spots along base; deep scars on the fore part of head. Body above brownish with numerous dark specks, below more dotted with gray; a transverse line of small whitish warts on occiput.] (*Kaup*.) MACULATUS, 61.

---

* There is no genus "*Muraenopsis* Le Sueur." Le Sueur used Lacépède's name, *Muraenophis*, for *Muraena*. This name was somewhere misprinted "*Muraenopsis*."

aa. Teeth of upper jaw in two or three series.

d. Mandibular teeth uniserial or nearly so; vomerine teeth in one series or slightly biserial in front.

e. Coloration uniform or nearly so. (*Cryptopterus* Kaup.)

f. [Mandibular teeth all uniserial; end of dorsal and anal hidden in a groove; insertion of dorsal $4\frac{1}{2}$ times diameter of eye behind base of pectoral; tail $\frac{1}{3}$ longer than head and trunk; head $2\frac{1}{3}$ in trunk; snout $5\frac{1}{3}$ in head; eye rather large, equidistant from tip of snout and angle of mouth; gill-openings close together, the isthmus less broad than one of them. Color slaty-blue.] (*Peters*) ....ATER, 62.

ff. [Mandibular teeth not quite uniserial, some in front forming a second series; dorsal and anal fins disappearing for some distance before their termination near the end of the tail; pectoral fin well developed; dorsal fin commencing at a short distance behind the end of the pectoral; tail $\frac{3}{5}$ of total length; eye of moderate size; cleft of mouth of moderate width. Coloration uniform.] (*Kaup* per *Günther.*) PUNCTICEPS, 63.

ee. Coloration not uniform; anterior teeth slightly enlarged; eye rather large, nearly median (*Ophichthus*).

g. Sides of body with one or more series of large, round, black spots; brown; head with numerous small dark spots and longitudinal folds; a series of large, round, dark spots along the side, the interspaces as wide as the spots; another series of alternate smaller spots along the back, and another along the sides of abdomen; fins yellowish, dorsal with a series of brown spots along the edge; eye large, looking upwards, $1\frac{2}{3}$ in snout; teeth moderate, those in front of upper jaw somewhat canine-like; pectoral fin well developed, its extremity nearly opposite to the origin of the dorsal fin; tail longer than rest of body ....HAVANNENSIS, 64.

gg. [Sides of body with round whitish spots between darker areas; color light olivaceous with about 20 oblong dark blotches along the median line of body and tail, the interspaces between these each a round pale spot about as large as eye. Dorsal inserted $1\frac{1}{5}$ length of pectorals behind the tips of pectorals; pectorals $2\frac{1}{2}$ in the distance from the snout to their base; eye $1\frac{1}{3}$ in snout, equal to interorbital space; cleft of mouth 3 in head; head 9 in length; gill-opening 5 in head; maxillary biserial; mandibular teeth uniserial; vomer with about 15 teeth.] (*Eigenmann.*)..............................RETROPINNIS, 65.

dd. Mandibular teeth in two to four series.

h. Vomerine teeth in one row; anterior teeth of jaws or vomer sometimes a little enlarged.

i. Teeth in both jaws biserial; the teeth of the inner series sometimes small and turned inward. (*Muranopsis* Kaup).

j. Sides of body without conspicuous dark spots or blotches; the spots when present mostly whitish.

k. Dorsal beginning behind the tip of the pectoral, at a distance equal to diameter of eye. Head $2\frac{2}{3}$ in trunk, $4\frac{2}{3}$ in tail; pectoral fin shorter than in *ocellatus*, $3\frac{1}{2}$ in head; eye $1\frac{1}{2}$ in snout; cleft of mouth $2\frac{1}{3}$ in head. Color very much as in *ocellatus*, but paler, rather light brown above, pale below, with about 20 round pale spots along the lateral line; lower jaw and throat rather pale, dusted with brown dots; pectoral pale, with a dusky border; a line of small white spots across the occiput, and a shorter but similar row on each side of head...GUTTIFER, 66.

kk. Dorsal fin beginning over or just before tip of pectoral.

l. Color rather dark brown above, lighter below, with about 20 round whitish spots along the side, averaging more than half the diameter of the eye; dorsal fin commencing over or a little before the tip of pectoral, light-colored with a narrow dark margin; anal light yellow; a row of small white spots across the top of head, sometimes coalescent into a band, and one or more similar but shorter rows on each side of head; pectoral decidedly dusky; jaws, throat, and chin dusted with brown dots. Vomer with about 15 teeth, the anterior inclined to form a double series; tail $\frac{1}{2}$ a head's length longer than head and trunk; head $2\frac{5}{6}$ in trunk; eye $1\frac{3}{4}$ in snout; snout $5\frac{1}{2}$ in head; cleft of mouth $2\frac{1}{2}$ in head; pectoral $2\frac{3}{4}$ in head ..OCELLATUS, 67.

ll. [Color above dark brown, below paler, the two colors separated by a water line; along the lower border of the dark part a series of small yellowish spots, half an inch apart, invisible posteriorly. Cleft of mouth $2\frac{1}{2}$ in head, which is half the length of the trunk; eye 2 in snout; pectoral 3 in head; the dorsal inserted just before its tip; terminal inch of dorsal and anal inclosed in ~~a~~ deep groove.] (*Cope.*) ....UNISERIALIS, 68.

jj. Sides of body with conspicuous black spots or blotches.

k. Back and sides with round black spots. Body terete, the tail $1\frac{1}{2}$ times the length of head and trunk; head flattish; mouth broad, its width as great as distance between the nostrils or as interorbital space; gill-openings vertical, well separated; dorsal fin beginning a little before the tip of the pectoral; head $2\frac{2}{3}$ in the trunk, $5\frac{1}{2}$ in the tail; pectoral fin $2\frac{3}{4}$ to $3\frac{1}{4}$ in the head, about equal to the lower jaw; cleft of mouth $2\frac{2}{3}$ in the head; gill-openings less than one-half the pectorals, less than the eye, $1\frac{1}{2}$ in the isthmus; eye $1\frac{1}{2}$ in snout, $2\frac{2}{3}$ in cleft of mouth; teeth rather strong, one or two in front of upper jaw almost canine-like; vomerine teeth small. Color light brown; a row of rather large round black blotches above the lateral line; a series of smaller spots on each side of dorsal, alternating with the large blotches; a row of submarginal spots along the dorsal fin, anal fin plain;

top and sides of head with smaller spots; in adults a faint, dusky shade across the pectoral; lower parts pale; longitudinal wrinkles on throat conspicuous........................ TRISERIALIS, 69.

kk. [Back with broad blackish cross-bands extending downwards to below lateral line, and alternating with large round dorsal spots; dorsal with a small blackish margin; anal blackish. Teeth all biserial, except on vomer; pectoral more than $\frac{1}{3}$ length of head; dorsal beginning before middle of pectoral; head $2\frac{1}{2}$ in trunk; tail longer than rest of body; cleft of mouth more than $\frac{1}{3}$ of head; eye $1\frac{2}{3}$ in snout and situated in the anterior part of head.] (*Günther.*) GRANDIMACULATUS, 70.

ii. [Teeth in both jaws in bands of 3 to 4 series in the adult. Color brown; a series of very small whitish dots along the anterior part of lateral line; some similar dots on nape; dorsal fin with a black edge; head $2\frac{1}{3}$ in trunk; cleft of mouth $2\frac{1}{2}$ in head; eye $1\frac{1}{2}$ in snout, situated in the anterior third of head; length of pectoral rather more than $\frac{1}{3}$ of head; dorsal fin low, commencing opposite the extremity of pectoral; tail longer than rest of body.] (*Günther*)................................... PACIFICI, 71.

hh. Vomerine teeth biserial throughout; teeth in both jaws biserial, subequal, no canines; color plain brownish, paler below. (*Scytalophis* Kaup.)

m. Eye large, more than half length of snout.

n. Head rather short, $2\frac{1}{3}$ to 3 times in the trunk.

o. Pectoral $2\frac{1}{5}$ to $2\frac{3}{5}$ in head, about as long as cleft of mouth, which is $2\frac{2}{3}$ in head. Body terete; the head about $2\frac{2}{3}$ times ($2\frac{1}{2}$ to 3) in the trunk; the head and trunk $1\frac{5}{7}$ ($1\frac{1}{2}$ "*chrysops*" to $1\frac{9}{10}$ "*macrurus*") in the tail; snout rather short, pointed; interorbital space broad, equal to eye, which is about $1\frac{1}{2}$ in snout; nasal tubes short; dorsal inserted behind middle of pectoral; diameter of gill-opening equal to eye, $1\frac{1}{2}$ in the isthmus, 3 in the pectoral. Olive brown above, the coloration caused by innumerable brown points on a yellowish ground; light yellow below; pectoral dusky, dark along the upper edge; lower jaw with dusky markings; dorsal and anal fin translucent, with dark margins; pores on jaws and head conspicuous................................GOMESI, 72.

oo. Pectoral longer, 2 to $2\frac{1}{5}$ in head, longer than the cleft of the mouth, which is $2\frac{1}{2}$ in head. Tail very nearly twice as long as rest of body; snout rather long; interorbital space narrow, less than eye; nasal tubes rather long, flattened, the edge uneven; dorsal commencing over or in front of the middle of pectoral: head $2\frac{1}{3}$ in the trunk; head and trunk a little more than half the tail; pectoral fin $2\frac{1}{5}$ in the head: eye $1\frac{1}{2}$ in the snout, $\frac{1}{2}$ greater than the interorbital width; gill-opening

less than eye, $1\frac{1}{4}$ in isthmus. Color brown above, light yellow below; opercular regions, lower jaw, throat, and pectoral dusky; dorsal and anal edged with black .... ZOPHOCHIR, 73.

nn. Head rather long, $1\frac{3}{4}$ to $2\frac{1}{3}$ in trunk.

p. Tail long, about $2\frac{1}{5}$ times length of rest of body; pectoral $2\frac{1}{2}$ in head; dorsal inserted over middle of pectoral; gape $2\frac{2}{5}$ in head; head $1\frac{3}{4}$ in trunk; eye about $2\frac{3}{4}$ in snout. Blackish, paler below; dorsal and anal yellowish brown, dotted and bordered with black .... MAGNIOCULIS, 74.

pp. Tail shortish, $1\frac{1}{3}$ times rest of body; head $2\frac{1}{6}$ in trunk; pectoral about 3 in length of head; cleft of mouth about 3 in head; gill-openings very wide, wider than in related species, broader than the isthmus; eye $1\frac{1}{2}$ in snout; teeth rather small, biserial in both jaws; fins low, the dorsal beginning over the end of the pectoral. Color uniform brown, paler below .... CALLAËNSIS, 75.

mm. [Eye small, about $2\frac{1}{2}$ times in the snout; gill-openings not very wide, approaching nearer together than usual in this genus; anterior nostril with an elongate tapering tube; head 2 in trunk; cleft of mouth $2\frac{2}{3}$ in head; eye $2\frac{1}{2}$ in snout; pectoral $2\frac{1}{4}$ in head; dorsal fin rather low, commencing above posterior third of pectoral; tail twice as long as rest of body; coloration uniform.] (*Günther.*) PARILIS, 76.

59. OPHICHTHUS HISPANUS.

? ? *Echelus rufus* Rafinesque, Carratteri, 65, 1810 (Palermo).

? ? *Echelus polyrinus* Rafinesque, Indice d'Ittiol. Sicil., 69, 1810 (Palermo), (may be *Ophisoma balearicum*).

Ophisurus hispanus Belotti, Accad. Fisico-medico Stat. Milano, 1857, (Barcelona) (*fide* Günther).

Ophichthys hispanus Günther, VIII, 72, 1870 (Cannes).

Habitat: Mediterranean Sea.

Etymology: *Hispanus*, Spanish.

This species is known to us from a specimen sent by Professor Doderlein from Palermo. Doderlein has identified this species with the *Echelus polyrinus* of Rafinesque, although the description of the latter writer could not well be worse. The description of *Echelus rufus* fits this species better, but the figure not at all. It is not impossible that both names were intended for young Congers, or perhaps for *Ophisoma*. The basis for the identification of *Echelus polyrinus* is apparently the common name "Gruncu di Rena," given by Rafinesque and still used for this species at Palermo.

60. OPHICHTHUS BRASILIENSIS.

Centrurophis brasiliensis Kaup, Apodes, 4, 1856 (Rio Janeiro).

Ophichthys brasiliensis Günther, VIII, 73, 1870 (copied).

Habitat: Coast of Brazil.

Etymology: Living in Brazil.

This species is known to us from Kaup's description only. He places it in his genus *Centrurophis*, which is characterized chiefly by the termination of the tail in a translucent thorny tip.

61. OPHICHTHUS MACULATUS.

Cogrus maculatus Rafinesque, Caratteri, 62, 1810 (*maculatus*).
Ophisurus pictus Swainson, Fish., Rep., and Amph., II, 395, 1839 (Sicily).
Centrurophis remicaudus Kaup, Apodes, 3, 1856 (Sicily).
Ophichthys remicaudus Günther, VIII, 73, 1870 (copied).

Habitat: Mediterranean Sea.

Etymology: *Maculatus*, spotted.

This rare species is known to us from descriptions only; as it seems to be Rafinesque's *Cogrus maculatus*, we have restored his specific name.

62. OPHICHTHUS ATER.

Ophichthys (*Herpetoichthys*) *ater* Peters, Monatsber. Akad. Wiss., 525, 1866 (Chile).
Ophichthys ater Günther, VIII, 68, 1870 (copied).

Habitat: Coast of Chile.

Etymology: Latin, black.

This species is known to us only from Peters' description.

63. OPHICHTHUS PUNCTICEPS.

Cryptopterus puncticeps Kaup, Aale Hamb. Mus., II, tab. 1, fig. 2, 1859 (Puerto Cabello) (*fide* Günther).
Ophichthys puncticeps Günther, VIII, 60, 1870 (copied).

Habitat: Caribbean Sea.

Etymology: *Punctus*, speckled; *ceps*, head.

This species is known to us from Kaup's description, as quoted by Günther.

64. OPHICHTHUS HAVANNENSIS.

? *Serpens marinus maculosus* Willughby, Hist. Pisc., tab. G 9, 1686 (no locality).
? *Muræna ophis* Linnæus, Syst. Nat., ed. x, 1758 (after Willughby) (and of the copyists); (may be identical with *Ophichthus regius*, a St. Helena species, likewise spotted with black).
? *Ophichthus ophis* Ahl, De Muræna et Ophichtho, 81, 1789 (generic description).
? *Muræna ophis* Bloch, Ichthyologia, tab. 154, 1790 (Surinam?).
? *Ophisurus ophis* Lacépède, Hist. Nat. Poiss., II, 1800 (after Bloch, as is shown by the enumeration of fin rays).
Innominado Parra, Dif. Piezas Hist. Nat., pl. 37, fig. 2, 1787 (Havana).
Muræna havannensis Bloch & Schneider, Syst. Ich., 491, 1801 (after Parra).
Ophisurus havannensis Poey, Memorias, II, 320, 1860 (Cuba).
Uranichthys havannensis Poey, Repertorio, II, 257, 1866; Poey, Synopsis, 426, 1868; Poey, Enumeratio, 155, 1875 (Cuba).
Ophichthys havannensis Günther, VIII, 67, 1870 (Cuba).
? *Ophisurus guttatus* Cuvier, Regne Animal, 1817, 232 (Surinam) (after Bloch, pl. 154).
? *Muræna maculosa* Cuvier, l. c. (after *Ophisurus ophis* Lacépède, which is based on Bloch, pl. 154).

Herpetoichthys sulcatus Kaup, Apodes, 8, fig. 5 (not 6) (no habitat).
Uranichthys brachycephalus Poey, Repertorio, II, 257, 1867 (Cuba); Poey, Synopsis, 426, 1865; Poey, Enumeratio, 155, 1875.

Habitat: West Indian fauna.

Etymology: Ὄφις, snake.

This species is known to us from descriptions only. We follow Dr. Günther in placing *sulcatus* and *brachycephalus* in the synonymy of *havannensis*. It may be that the unidentified old name of *ophis* belongs to this species, rather than to *Ophichthus regius* or to *Mystriophis intertinctus*, both of which, like *O. havannensis*, have the coloration ascribed to *Muræna ophis*. There can be little doubt that the specimen very well figured by Willughby is a species of *Ophichthus*. The figure of Bloch, on which the names *guttatus* and *maculosa* have been founded, seems to have been identical with the figure of Willughby.

65. OPHICHTHUS RETROPINNIS.

Ophichthys retropinnis Eigenmann, Proc. U. S. Nat. Mus., 116, 1887 (Pensacola, Fla.).

Habitat: Gulf of Mexico.

Etymology: Latin, *retropinnis*, having backward fins.

This species is based on a single specimen taken from the stomach of some large fish from the Snapper Banks near Pensacola; it seems allied to *Ophichthus ocellatus*, but the dorsal is much farther back than usual, and the teeth are different. These characters have been verified by Dr. Bean, who has kindly reëxamined Dr. Eigenmann's type for us.

66. OPHICHTHUS GUTTIFER.

Ophichthys guttifer Bean & Dresel, Proc. Biol. Soc. Wash., 100, 1882 (Pensacola); Jordan, Cat. Fish. N. A., 53, 1885.

Habitat: Gulf of Mexico.

Etymology: *Gutta*, spot; *fero*, I bear.

This species is as yet known only from a few specimens obtained from the stomachs of large groupers on the Snapper Banks near Pensacola. The single large example before us was obtained by Mr. Silas Stearns. The species is very close to *O. ocellatus*, from which it differs slightly in form and in the insertion of its dorsal. Possibly a large series would show it to be a variation of *O. ocellatus*.

67. OPHICHTHUS OCELLATUS.

Murenophis ocellatus Le Sueur, Journ. Acad. Nat. Sci. Phila., V, 108, pl. 4, fig. 3, 1825 (South America.) (*fide* Günther).
Ophisurus ocellatus Richardson, Voyage Erebus and Terror, Fishes, 104, 1844 (Mexico) (*fide* Günther).
Murænopsis ocellatus Kaup, Apodes, 1856.
Ophichthys ocellatus Günther, VIII, 68, 1870 (Mexico); Jordan & Gilbert, Syn. Fish. N. A., 359, 1883.
Herpetoichthys ocellatus Goode & Bean, Proc. U. S. Nat. Mus., 155, 1879 (Pensacola).
Ophisurus remiger Valenciennes, in D'Orbigny Voy. Amér. Mérid., Poiss., pl. 12, fig. 2, 1839 (*fide* Günther).

Habitat: West Indian fauna, north to Florida.

Etymology: Latin, ocellate, from the spots.

Generally common in the West Indies. We have before us several large examples obtained on the Snapper Banks near Pensacola.

68. OPHICHTHUS UNISERIALIS.

Ophichthys uniserialis Cope, Proc. Amer. Phil. Soc., 31, 1877 (Bay of Pacasmayo, Peru).

Habitat: Coast of Peru.

Etymology: Latin, one-rowed.

This species is known to us from Cope's description.

69. OPHICHTHUS TRISERIALIS.

Murænopsis triserialis Kaup, Apodes, 12, 1856 (Pacific).

Ophichthys triserialis Günther, VIII, 58, 1870 (Pacific; Caribbean Sea; Bahia); Streets, Bull. U. S. Nat. Mus., 55, 1877 (Gulf of California); Jordan & Gilbert, Proc. U. S. Nat. Mus., 457, 1880; Jordan & Gilbert, Bull. U. S. Fish Com., 101, 1882 (Mazatlan); Jordan & Gilbert, Proc. U. S. Nat. Mus., 37, 1881; Jordan & Gilbert, Syn. Fish. N. A., 359, 1883; Jordan, Proc. U. S. Nat. Mus., 370, 1885.

Herpetoichthys callisoma Abbott, Proc. Acad. Nat. Sci. Phila., 475, 1860 (locality unknown).

Ophisurus californiensis Garrett, Proc. Acad. Nat. Sci. Cal., 66, 1863 (coast of Lower California).

Ophichthus rugifer Jordan & Bollman, Proc. U. S. Nat. Mus., 155, 1889 (Charles Island).

Habitat: Pacific coast of Mexico; Brazil?

Etymology: Latin, three-rowed.

This species is not rare on the Pacific coast of tropical America. It has also been accredited to the Atlantic (Caribbean sea; Bahia) by Dr. Günther. This record needs verification, as perhaps the related species, *O. havannensis*, has been mistaken for it.

There is no doubt of the identity of Garrett's *californiensis* with the species commonly called *triserialis*. The original type of Garrett's description in the Museum of the Academy of Natural Sciences at San Francisco has been examined by us. The description of *Herpetoichthys callisoma* applies well to the species in question.

The form called *O. rugifer*, of which two specimens from Chatham Island in the Galapagos, are now before us, seems to differ only in the greater length of the pectoral. This is probably due to their youth, and we have little hesitation in referring *O. rugifer* to the synonymy of *triserialis*.

70. OPHICHTHUS GRANDIMACULATUS.

Ophichthys grandimaculata Kner & Steindachner, Sitzgsber. Akad. Wiss. Wien, 389, fig. 13, 1866 (Peru, *fide* Günther); Günther, VIII, 58, 1870 (Peru).

Habitat: Coast of Peru.

Etymology: *Grandis*, large; *maculatus*, spotted.

This species is known to us from descriptions only.

71. OPHICHTHUS PACIFICI.

Ophichthys pacifici Günther, VIII, 76, 1870 (Valparaiso, Chile; Tambo River, Peru).

Habitat: Coasts of Chile and Peru.

Etymology: From the Pacific Ocean.

This species is known from Günther's description only.

72. OPHICHTHUS GOMESI.

(SEA SERPENT.)

Ophisurus gomesii Castelnau, Anim. Amer. Sud, 84, pl. 44, fig. 2, 1855 (Rio Janeiro).

Leptorhinophis gomesii Kaup, Apodes, 14, 1856 (copied).

Ophichthys gomesii Günther, VIII, 60, 1870 (copied).

Ophisurus chrysops Poey, Memorias, II, 321, 1867 (Havana).

Ophichthys chrysops Poey, Repertorio, II, 255, 1867; Poey, Synopsis, 425, 1868; Poey, Enumeratio, 154, 1875; Jordan & Gilbert, Proc. U. S. Nat. Mus., 261, 1882 (Pensacola); Jordan & Gilbert, ibid, 487 (Charleston).

Ophichthys chrysops Jordan & Gilbert, Syn. Fish. N. A., 898, 1883; Jordan, Cat. Fish. N. A., 53, 1885.

Oxyodontichthys chrysops Poey, Anal. Soc. Hist. Nat. Esp., 254, 1880 (Cuba).

Oxyodontichthys macrurus Poey, Anal. Soc. Hist. Nat. Esp., 254, 1880 (Havana).

Oxyodontichthys brachyurus Poey, Synopsis, 426, 1868 (Havana); Poey, Enumeratio, II, 155, 1875.

Oxyodontichthys limbatus Poey, Anal. Hist. Nat. Esp., 254, 1880 (based on type of *O. brachyurus*).

Habitat: West Indian fauna, Charleston to Rio Janeiro.

Etymology: Named for Dr. Ildefonso Gomes, who cured the Comte de Castelnau of a dangerous malady in Rio Janeiro.

This species is generally common in the West Indies, ranging as far north as Charleston, Galveston, and Pensacola. The specimens before us are from the Snapper Banks of Pensacola, from St. Augustine, Florida, and from Charleston, South Carolina.

A careful comparison of our specimens with the various published descriptions leads us to regard *chrysops*, *macrurus*, and *brachyurus* as synonyms of *O. gomesi*. In most respects these nominal species fully agree. Our specimens correspond best to the descriptions of *chrysops*, from which *brachyurus* (afterwards called *limbatus*) seems to be inseparable. *Macrurus* is said to have the head and body contained $1\frac{1}{2}$ times in the tail, while in *chrysops* the number is $1\frac{2}{3}$, and in *brachyurus* $1\frac{5}{7}$. Our specimens show the ratio of $1\frac{5}{7}$ to $1\frac{3}{4}$. As these numbers are intermediate, and as no other difference appears, we refer all to the same species. *O. gomesi*, poorly described and figured by Castelnau, is probably the same species, rather than *O. parilis*.

The following are the chief characters given in the descriptions of the different nominal species here referred to the synonymy of *Ophichthus gomesii*: In a specimen before us from St. Augustine the head is $2\frac{2}{3}$ in the trunk, the head and trunk is $1\frac{2}{3}$ in the tail, cleft of mouth $2\frac{4}{5}$ in head. In one from Charleston (29970 U. S. Nat. Mus.) the head is $2\frac{1}{3}$ in trunk, the head and trunk $1\frac{2}{3}$ in tail, the cleft of the mouth $2\frac{2}{3}$ in head. In one from Pensacola (43117) these figures are $2\frac{1}{2}$, $1\frac{4}{5}$, and $2\frac{2}{3}$.

Leptorhinophis gomesi Kaup, head 2.88 in trunk; head and trunk 1.74 in tail; cleft $2\frac{1}{2}$ in head.
Ophichthys chrysops Poey, head $2\frac{1}{5}$ in trunk; head and trunk $1\frac{1}{2}$ in tail.
Ophichthys chrysops Jordan & Gilbert, head and trunk $1\frac{5}{7}$ in tail; cleft $2\frac{3}{5}$ in head.
Ophichthus macrurus Poey, head $2\frac{5}{6}$ in trunk; head and trunk $1\frac{10}{11}$ in tail.
Ophichthys macrurus Jordan & Gilbert, head $2\frac{2}{3}$ in trunk; head and trunk $1\frac{4}{5}$ and $1\frac{5}{7}$ in tail; cleft $2\frac{2}{3}$ in head.
Ophichthys brachyurus Poey, head 3 in trunk; head and trunk $1\frac{5}{7}$ in tail.

Should two species be found in the above synonymy they are probably *gomesi* with head and body $1\frac{1}{2}$ to $1\frac{5}{7}$ in tail, and *macrurus* with head and body $1\frac{4}{5}$ to $2\frac{1}{8}$ in tail.

73. OPHICHTHUS ZOPHOCHIR.

Ophichthys zophochir Jordan & Gilbert, Proc. U. S. Nat. Mus., 347, 1881 (Mazatlan); Jordan & Gilbert, Proc. U. S. Nat. Mus., 623, 1882 (Acapulco).

Habitat: Pacific coast from Gulf of California to Acapulco or beyond.

Etymology: *Ζόφος*, dusky; *χείρ*, hand (pectoral fin).

This species is rather common on the Pacific coast from the Gulf of California southward. The specimen before us is from Guaymas. The species is very nearly related to *O. gomesi*, which it represents on the Pacific coast, and from which it may prove to be indistinguishable.

74. OPHICHTHUS MAGNIOCULIS.

Scytalophis magnioculis Kaup, Apodes, 13, fig. 7, 1856 (St. Croix, Brazil).
Ophichthys magnioculis Kner, Novara Fische, 376, 1866 (Rio Janeiro).
Ophichthys magnoculus Günther, VIII, 59, 1870 (copied).

Habitat: Brazilian fauna.

Etymology: *Magnus*, great; *oculus*, eye.

This species is known to us from a specimen (38522) obtained by the *Albatross* at Aspinwall. The short trunk and long tail separate it from *O. gomesi*.

75. OPHICHTHUS CALLAËNSIS.

Ophichthys callaënsis Günther, Journal Museum Godeffroy, IV, 92, 1873 (Callao).

This species is known to us from a specimen (36931, U. S. Nat. Mus.) from Coquimbo, Chile, and from a specimen (1078, M. C. Z.) received by the Indiana University from the Museum at Cambridge. This specimen is from Valparaiso and was sent under the name of *Ophichthys remiger*. As Günther has indicated, *O. callaënsis* is a near relative of *O. magnioculis*, from which it differs in its larger gill-openings and shorter tail.

The following is Dr. Günther's original description, kindly furnished us by Dr. G. A. Boulenger:

OPHICHTHYS CALLAËNSIS.

Diese neue Art gehört zu der Abtheilung 1, A, 1, *b* *β*, meiner Synopsis (Fish, VIII, p. 55). Die Kiemenöffnungen sind weit, weiter als der Zwischenraum, durch den sie an der Bauchseite von einander getrennt sind. Die Länge des Kopfes ist mehr

als die Hälfte der Entfernung der Kiemenspalte vom After. Die Schnautze springt über den Unterkiefer vor. Länge der Maulspalte ⅓ der Kopflänge. Auge ziemlich gross, mehr als halb so lang als die Schnautze. Zähne ziemlich gleichmässig klein, in doppelten Reihen in beiden Kiefern. Die Länge der Brustflosse ist ⅖ der Kopflänge. Rücken und Afterflosse sehr niedrig, die erstere fängt über dem Endtheile der Brustflosse an. Die Körperlänge verhält sich zur Schwanzlänge = 2:3. Einfärbig braun, heller am Bauche. Ein Exemplar, 10 Zoll lang, von Callao (No. 21). Es scheint diese Art dem *Ophichthys magnioculus* verwandt zu sein, unterscheidet sich aber durch seine Körperverhältnisse. (Zweiter ichthyologischer Beitrag nach Exemplaren aus dem Museum Godeffroy, von Dr. Albert Günther, Journal des Museum Godeffroy, Heft. IV, p. 91, 1873).

Our specimens have the head a little less than half the length of the trunk, and the pectoral fin about 3 times in head.

Ophichthys dicellurus (Richardson), a Chinese species, has also been recorded from Coquimbo, Chile, by Dr. Günther, Proc. Zoöl. Soc. London, 1881, 22, without description. Perhaps *O. callaënsis* was intended.

76. OPHICHTHUS PARILIS.

Ophisurus parilis Richardson, Voyage Erebus and Terror, 105, 1844 (West Indies); Kaup, Apodes, 14, fig. 8, 1856 (Brazil; Surinam; West Indies).

Ophichthys parilis Günther, VIII, 59, 1870 (Cuba; Bahia).

Ophichthys pauciporus Poey, Repertorio, II, 255, lam. 3, fig. 5, 1868; Günther, VIII, 60, 1870; Poey, Enumeratio, 154, 1875.

Habitat: West Indies to Brazil.

Etymology: *Parilis*, like.

This species is known to us only from descriptions. It appears to differ from *O. gomesi* in the longer nasal tubes, and especially in the smaller eye.

We refer *O. pauciporus* Poey to the synonymy of *O. parilis* with some doubt. Poey's figure shows the small eye of *O. parilis*, and rather large nasal tubes. The tail in *pauciporus* is said to be twice as long as the rest of body, as in *parilis*. In *pauciporus* the insertion of the dorsal is said to be behind (*mas atras*) the end of the pectoral. It is before the tip in *parilis*, but this is likely either an error or an individual variation. No other difference appears in the descriptions.

Genus 16.—MYSTRIOPHIS.

Mystriophis Kaup, Apodes, 10, 1856 (*rostellatus*).

Echiopsis Kaup, Abhandl. Naturh. Verein., l. c., 13 (*intertinctus*).

Crotalopsis Kaup, Abhandl. Naturwiss. Verein. Hamburg, IV, 12, 1860 (*punctifer*).

Macrodonophis Poey, Repertorio Fis. Nat. Cuba, II, 251, 1867 (*mordax*).

Scytalichthys Jordan & Davis, subgen. nov. (*miurus*).

Type: *Ophisurus rostellatus* Richardson.

Etymology: Μυστρίον, a spoon, from the form of the snout of the typical species; ὄφις, snake.

This genus as understood by us contains about four species distinguished from *Ophichthus* by the canine teeth and large mouth. The species have not much in common, and should perhaps be ranged in three different genera, unless all are replaced in *Ophichthus*.

ANALYSIS OF SPECIES OF MYSTRIOPHIS.

a. Jaws narrowed and not expanded at tip.

b. Vomerine teeth small, biserial or triserial, fixed; tail moderate. (*Echiopsis* Kaup.)

c. Teeth in jaws biserial; long canines in front of jaws; outer teeth of upper jaw unequal, some of them canine; vomerine teeth in two series, these sometimes partly coalescing (sometimes, var. *punctifer*, partly divided into three); lower jaw scarcely included; pectoral fin about 5 in the head; tail a little longer than rest of body; dorsal commencing behind tip of the pectoral, a distance equal to about the length of same; isthmus equal to $\frac{3}{8}$ the gill-openings, which are large, close together, and subinferior, anterior in position; head $2\frac{1}{3}$ to $2\frac{5}{6}$ in the trunk; eye small, $1\frac{1}{2}$ to 2 in the snout; gape $2\frac{1}{4}$ in head; snout 3 in cleft of mouth, 7 in head. Dark brown above, paler below, side with two rows of large round or ovate black spots, the upper row close to the dorsal fin, the lower row below the lateral line; besides these some smaller spots, also black; head a little darker than the body, the spots smaller and numerous, some larger ones below eye; dorsal and anal with dark borders formed by spots; pectoral black at tip, the remainder more or less dusky .... INTERTINCTUS, 77.

bb. Vomerine teeth in one series of about 4 slender depressible canines; tail very short, much shorter than rest of body. (*Scytalichthys* Jordan & Davis.)

dd. Dorsal fin inserted well behind tip of pectorals; gill-opening midway between eye and beginning of dorsal fin; pectoral fin very short, as long as snout, 10 in head; snout short, 4 in cleft of mouth; head depressed and pointed, the mouth large; teeth long, those on vomer and side of lower jaw canine-like; teeth of upper jaw biserial, rather small; lower teeth uniserial; vomerine teeth uniserial; eye small, placed well forward; gill-openings small, transverse, inferior, as in *Cæcula imberbis*, the slit as long as snout and wider than isthmus; head $4\frac{3}{5}$ in the very long trunk; tail $1\frac{4}{7}$ in rest of body; cleft of mouth $2\frac{1}{5}$ in head. Coloration light yellowish, a series of roundish dark-brown blotches on each side of body, the two series alternating; two alternating series of small half blotches on the back, these coalescing into one on median line before dorsal; head with small dark spots; sides of lower jaw spotted; fins pale .... MIURUS, 78.

77. MYSTRIOPHIS INTERTINCTUS.

Ophisurus intertinctus Richardson, Voy. Erebus and Terror, Fishes, 102, 1844 (West Indies).

Echiopsis intertinctus Kaup, Apodes, 13, 1856 (Martinique).

Ophichthys intertinctus Günther, VIII, 57, 1870; Jordan, Proc. Acad. Nat. Sci. Phila., 43, 1884 (Egmont Key, Fla.); Jordan, Cat. Fish. N. A., 53, 1885.

? *Ophisurus sugillatus* Richardson, Voyage Erebus and Terror, 1844, 103 (habitat uncertain; supposed to be West Indies).

Crotalopsis punctifer Kaup, Abhandl. Wiss. Verein. Hamb., IV, 2, 12, taf. 1, fig. 3, 1860 (1859) (Puerto Cabello) (*fide* Günther).

Ophichthys punctifer Günther, 56, 1870 (copied).

Conger mordax Poey, Memorias, II, 319, 1860 (Cuba).

Macrodonophis mordax Poey, Repertorio, II, 252, 1868; Poey, Synopsis, 425, 1868.

Crotalopsis mordax Poey, Enumeratio, 153, 1875; Goode & Bean, Proc. U. S. Nat. Mus., 344, 1879 (Clear Water Harbor, Fla.).

Ophichthys schneideri Steindachner, Ich. Beitr., VIII, 66, 1879 (Brazil); Jordan & Gilbert, Proc. U. S. Nat. Mus., 143, 1883 (Pensacola); Jordan, Cat. Fish. N. A., 53, 1885.

Habitat: West Indian fauna, north to western Florida.

Etymology: Latin, colored between or within.

This species is not rare in the West Indies, and has been occasionally taken on the west coast of Florida. The four examples before us are from Lemon Bay, Egmont Key, St. Thomas, and Pensacola. A careful comparison of the descriptions of different writers with our specimens leads us to the conclusion that the forms called *intertinctus*, *punctifer*, *schneideri*, and *mordax* belong to one species. *O. schneideri* is said to have the vomerine teeth biserial, while in *punctifer* (=*mordax*) they are triserial. Our specimens have the teeth biserial or somewhat triserial in front. In the forms called *intertinctus* the teeth are biserial in front and uniserial behind. In the type of *O. sugillatus* the vomerine teeth are said to be uniserial. This species is said to have the pectorals longer than in *intertinctus*, as long as eye and snout. Probably all these characters represent variation of individuals.

78. MYSTRIOPHIS MIURUS.

Ophichthys miurus Jordan & Gilbert, Proc. U. S. Nat. Mus., 387, 1882 (Cape San Lucas).

Habitat: Pacific coast of Mexico.

Etymology: *Μειοῦρος*, curtailed, from the short tail.

This species is known only from two specimens, both taken at Cape San Lucas by Mr. John Xantus. One of these, 43104, has been only lately found in the Museum collections.

This species has little relation to any other found in America, although in coloration it is much like *intertinctus*, *ophis*, and *triserialis*.

Genus 17.—BRACHYSOMOPHIS.

Brachysomophis Kaup, Apodes, 9, 1856 (*horridus*).

? **Achirophichthys** Bleeker, Poissons Inéd. Murènes, Ned. Tijdschr. Dierk., II, 42; *typus* = young.

Type: *Brachysomophis horridus* Kaup.

Etymology: *Βραχύς*, short; *σῶμα*, body; *ὄφις*, snake.

This East Indian genus is once recorded in our fauna.

ANALYSIS OF THE SPECIES OF BRACHYSOMOPHIS.

a. [Teeth unequal in size; maxillary teeth in a double row, those of the inner row stronger and less numerous than the outer; vomerine and mandibular teeth uniserial; large canine teeth; head 3 in trunk; snout extremely short and rather flattened, scarcely twice as long as the eye, which is small and situated in the anterior ninth of the length of the head; vertical fins moderately well developed; distance between the origin of the dorsal fin and gill-opening 2½ in head; pectoral small; body longer than tail. Upper parts brownish, minutely dotted with darker; a series of black pores along the lateral line, sometimes a whitish line across the occiput.] (*Günther.*) .... CROCODILINUS, 79.

79. BRACHYSOMOPHIS CROCODILINUS.

Ophisurus crocodilinus Bennett, Proc. Com. Zoöl. Soc., 32, 1831 (*fide* Günther).

Ophichthys crocodilinus Günther, VIII, 64, 1870 (Galapagos Islands).

Brachysomophis horridus Kaup, Apodes, 9, fig. 6, 1856 (Otaheite); Bleeker, "Versl. Medel. Akad. Wet. Amsterd., II, 303, 1868" (*fide* Günther).

?*Achirophichthys typus*, Bleeker, Ned. Tydschr. Dierk., 42 (Celebes).

Habitat: East Indies; once found at the Galapagos Islands.

Etymology: Latin, like a crocodile.

This species, said to have been once taken at the Galapagos, is known to us only through descriptions.

Genus 18.—OPHISURUS.

Ophisurus Lacépède, Hist. Nat. Poiss., II, 1800 (*ophis; serpens*).
Oxystomus Rafinesque, Caratteri, 62, 1810 (*hyalinus* = *serpens*, young).
Ophisurus Risso, Europe Méridionale, III, 206, 1826 (restricted to *serpens*).
Leptognathus Swainson, Natur. Hist. Class'n. Fish., II, 234, 1839 (*oxyrhynchus* = *serpens*).
Leptorhynchus Smith, Illustr. Fishes S. Afr., 1840 (*capensis*) (the name six times preoccupied).
Ophisurus Kaup, Apodes 7, 1856 (*serpens*, not of Lacépède as restricted by Swainson and Bleeker).

Type: *Muræna serpens* L.

Etymology: Ὄφις, snake; οὐρά, tail.

This genus is based on a single species found in the seas of Europe. In form of snout it differs materially from the other Ophisuroid eels, approaching in some degree to the beloniform jaws of *Nemichthys*. We adopt the name *Ophisurus* instead of *Oxystomus* or *Leptognathus*. The earliest restriction of Lacépède's genus, that of Risso, made *serpens*, the type of *Ophisurus*. The association of the name *Ophisurus* with the blunt-toothed species here called *Myrichthys* rests wholly on errors.

ANALYSIS OF THE SPECIES OF OPHISURUS.

a. Body slender, subterete; head $3\frac{1}{2}$ in trunk; head and trunk $2\frac{3}{4}$ in total length; cleft of mouth half as long as head; snout $3\frac{2}{5}$ in head; eye large, 3 in snout, nearer angle of mouth than tip of snout; dorsal beginning behind base of pectorals at a distance equal to twice the length of pectorals; pectorals $1\frac{3}{4}$ in snout. Color olivaceous, silvery below; covered with many small brown specks, more numerous on back.

80. OPHISURUS SERPENS.

Muræna exacte teres cauda acuta apterygia Artedi, Genera Piscium, 24, 1738 (Rome).
Muræna serpens Linnæus, Syst. Nat., ed. X, 244, 1758, (after Artedi) (and of copyists).
Ophisurus serpens Lacépède, Hist. Nat. Poiss., II, 198, 1801 (*fide* Günther).
Ophichthys serpens Günther, VIII, 65, 1870 (Bay of Naples; Atlantic; Damara Land; Japan; Australia).
Echelus oxyrinchus Rafinesque, Caratteri, 64, 1810 (Sicily).
Leptognathus oxyrhinchus, Swainson, Fish. Rep. and Amph., II, 396, 1839 (Sicily).
Echelus microphthalmus Rafinesque, Caratteri, 64, 1810 (Palermo).
Oxystomus hyalinus Rafinesque, Indice, 62, 1810 (Palermo: larva).
Leptorhynchus capensis Smith, Ill. Zoöl. S. Afr., Pisc., pl. 6, 1838 (*fide* Günther).
Muræna acutirostris Gronow (ed. Gray), Cat. Fishes, 19, 1854 ("America").
? *Ophisurus macrorhynchus* Bleeker, Verh. Bat. Gen., XXV, Muræna, 28, 1865 (Japan) (*fide* Günther).

Habitat: Southern Europe and southward, said to extend its range to Cape of Good Hope and Japan.

Etymology: *Serpens*, serpent.

Of this species we have one large specimen taken by Professor Doderlein at Palermo. Whether the Japanese and African representatives of this type are specifically identical with *Ophisurus serpens* we do not know. They are so considered by Dr. Günther.

Oxystomus hyalinus is a name applied to a young eel with translucent body and long and slender jaws, the lower the longer, taken by Rafinesque at Palermo. It is evidently the young of *O. serpens*.

Family III.—ECHELIDÆ.

(THE WORM EELS.)

We recognize provisionally as a distinct family the *Myrophinæ*, or *Myrinæ* of authors, small eels intermediate in character between the *Ophisuridæ* and the *Murænesocidæ*. The osteology has not yet been carefully studied, but they will probably be found to be most nearly related to the latter family, if indeed the two should not be, as in Bleeker's arrangement, reunited with the *Congridæ*.

The *Echelidæ* have the end of the tail surrounded by the confluent vertical fins; the posterior nostril is in or very near the upper lip, and the tongue is more or less fully adnate to the floor of the mouth.

The species are usually of small size and plain colors, more or less worm-like in form, and inhabit sandy coasts in tropical seas. Few of the genera are rich in species.

ANALYSIS OF AMERICAN AND EUROPEAN GENERA OF ECHELIDÆ.

a. Body short, much compressed; pectorals almost invisible; mouth narrow; vomerine teeth none; snout obtuse, depressed; vertical fins well developed, the dorsal beginning behind the gill-opening.................CHILORHINUS, 19.

aa. Body elongate, subterete; pectorals present, sometimes minute; anterior nostril tubular; dorsal fin beginning behind head; teeth small.

b. Dorsal fin beginning behind vent; no teeth on vomer; teeth mostly uniserial; body slender, terete ....AHLIA, 20.

bb. Dorsal fin beginning before the vent; vomer with teeth.

c. Dorsal fin beginning at a point about midway between gill-opening and vent; pectorals very small; teeth subequal; body slender, terete; the tail much longer than rest of body ....MYROPHIS, 21.

cc. Dorsal fin beginning close behind base of pectoral; tail longer than rest of body; pectoral well developed.

d. Teeth in jaws mostly biserial..............................PARAMYRUS, 22.

dd. Teeth in jaws in cardiform bands..........................ECHELUS, 23.

Genus 19.—CHILORHINUS.

Chilorhinus Lütken, Vidensk. Meddel. Naturh. Foren. Kjöbenhavn, 1, 1851 (*suensonii*).

Type: *Chilorhinus suensonii* Lütken.

Etymology: *Χεῖλος*, lip; *ῥιν*, nostril.

This genus is known from a single West Indian species.

ANALYSIS OF THE SPECIES OF CHILORHINUS.

a. [Head and trunk forming $\frac{2}{5}$ of the total length; dorsal fin commencing at a point half way between vent and snout; depth 9 times in the total length; eye $2\frac{1}{2}$ in interorbital width, latter equaling the muzzle; teeth on palatines biserial; ten teeth in two transverse rows on the nasals; teeth on lower jaw triserial. Color uniform dark brown; throat paler; fins darker-margined] (*Cope*). SUENSONII, 81.

81. CHILORHINUS SUENSONII.

Chilorhinus suensonii Lütken, Vid. Med. Naturh. Foren., 1, 1851 (St. Croix): Lütken, Wiegmann's Archiv, 272, 1852; Günther, VIII, 52, 1870 (copied); Cope, Trans. Amer. Phil. Soc., 482, 1870 (St. Croix).

Habitat: West Indian fauna.

Etymology: A personal name.

This species is known to us only from the descriptions of Lütken and Cope. The known specimens are from St. Croix.

Genus 20.—AHLIA.

Ahlia Jordan & Davis, gen. nov. (*egmontis*).

Type: *Myrophis egmontis* Jordan.

Etymology: Named for Jonas Nicolas Ahl, of Upsala, whose thesis "De Muræna et Ophichtho" "modestly offered for the consideration of the president of the medical faculty" in the University of Upsala ("Carolus Vet. Thunberg") in 1789, furnishes the beginning of our systematic arrangement of the eels.

A single species of this genus is known.

ANALYSIS OF THE SPECIES OF AHLIA.

a. Dorsal beginning behind vent, at a distance about equal to length of gape; anterior nostril in a short tube; posterior, large, labial, directly behind it; cleft of mouth short, extending beyond the rather large eye, $3\frac{1}{6}$ in head; eye 2 in snout; teeth on both jaws uniserial; four small canines in front of upper jaw; no teeth on vomer; lower jaw considerably shorter than the upper; top of head with large pores; head $4\frac{1}{5}$ in trunk; head and trunk a little shorter than tail; pectorals short and broad, slightly longer than snout; gill-opening short, oblique, extending downward and backward from near middle of base of pectoral. Dark brown, nearly uniform, somewhat paler below .... EGMONTIS, 82.

82. AHLIA EGMONTIS.

Myrophis egmontis Jordan, Proc. Acad. Nat. Sci. Phila., 44, 1889 (Egmont Key, Florida); Jordan, Cat. F. N. A., 54, 1885.

Habitat: Coast of Florida.

Etymology: From Egmont Key.

This species is known from the single example taken at Egmont Key, Florida.

Genus 21.—MYROPHIS.

Myrophis Lütken, Vidensk. Meddel. Nat. Foren. Kjöbenhaven, 1, 1851 (*punctatus*).

Type: *Myrophis punctatus* Lütken.

Etymology: *Μῦρος*, *Myrus*; *ὄφις*, snake.

This genus contains three species of small eels, resembling earthworms, found on the sandy shores of tropical America.

ANALYSIS OF THE SPECIES OF MYROPHIS.

a. Pectoral fin very small, no larger than the pupil of the eye. Body cylindrical, vermiform, the head small and jaws rather weak; gill-openings very small, $1\frac{1}{2}$ the diameter of the eye, 3 to 4 in the isthmus, which is about as wide as the length of the lower jaw; teeth uniserial in all the bones of the mouth; dorsal fin commencing at a distance about twice the length of head behind the gill-openings; head $4\frac{2}{5}$ in the trunk; head and trunk $1\frac{3}{5}$ in tail; eye $2\frac{1}{3}$ in the snout, situated just back of the middle of gape, which is $3\frac{1}{2}$ in head; depth of body at vent containing the snout twice and contained in the head $2\frac{3}{4}$ times. General color light brown, the dorsal region appearing darker because of the multitude of minute dark-brown specks; a light streak running from beginning of dorsal forward to the nape; nape and back of head a little darker in color. FRIO, 83.

aa. Pectoral fin larger, $1\frac{1}{2}$ to 2 times the diameter of the eye.

b. Base of pectoral fin half the width of the gill-opening; snout very narrow; jaws weak; width of snout between the anterior nostrils less than diameter of eye; width of interorbital space equal to eye; greatest width of head less than that of body behind the gill-openings; teeth uniserial on vomer and mandible, biserial on maxillary; head 3 times in the trunk, 7 times in the tail; depth of body at gill-openings $2\frac{3}{4}$ in the head; eye 2 in snout, which is 6 in the head; gape $3\frac{1}{2}$ in head; upper jaw projecting. General color light brown, the sides and back punctate with dark-brown dots; belly and throat plain, except a little patch of dusky points below the gill-openings........PUNCTATUS, 84.

bb. Base of pectoral fin as wide as the gill-opening; snout almost as broad as long; width at the nostrils greater than the interorbital width; dorsal commencing nearer the vent than the gill-openings; teeth uniserial on vomer and mandible, biserial on maxillary; head a little less than three in the trunk, $5\frac{1}{2}$ in the tail; depth of body at the gill-openings $3\frac{1}{2}$ to 4 in the head; upper jaw projecting. Color light brown; sides and back with minute brown specks, smaller than in *punctatus*; belly and throat plain ....VAFER, 85.

83. MYROPHIS FRIO.

Myrophis frio Jordan & Davis, sp. nov. (Cape Frio).

Habitat: Coast of Brazil.

Etymology: From the original locality, Cape Frio.

This species is known from a single example, $12\frac{1}{2}$ inches long, collected by the *Albatross* at Station 2762, off Cape Frio, near Rio Janeiro.

The species is well separated from the others by the minute pectoral, which is almost invisible. This species is intermediate between *Myrophis* and the East Indian genus *Murænichthys*, which differs only in the total absence of pectorals.

84. MYROPHIS PUNCTATUS.

Myrophis punctatus Lütken, Vid. Med. Naturh. Foren. Kjöben., 1, 1851 (West Indies); Jordan, Proc. Acad. Nat. Sci. Phila., 282, 1883 (description of Lütken's type); Jordan, Proc. U. S. Nat. Mus., 33, 1884 (Pensacola); Jordan, Cat. Fish. N. A., 54, 1885; Jordan & Evermann, Proc. U. S. Nat. Mus., 474, 1886 (Pensacola); Jordan, ibid, 567.

Myrophis longicollis Kaup, Apodes, 30, 1856 (Surinam) (not *Muræna longicollis* Cuvier); Peters, Monatsber. Akad. Wiss. Ber. 397, 1864.

Myrophis microstigmius Poey, Repertorio, II, 250, 1867 (Cuba); Poey, Synopsis, 425, 1868; Poey, Enumeratio, 153, 1875; Jordan & Gilbert, Syn. Fish. N. A., 900, 1883.

Myrophis lumbricus Jordan & Gilbert, Syn. Fish. N. A., 899, 1883 (Galveston, Tex.).

Habitat: West Indian fauna, from Texas to Surinam.

Etymology: Latin, speckled.

This species is common in the West Indies and along the Gulf coast of the United States. The specimens before us are from the Snapper Banks near Pensacola. We reject the name *longicollis* for this species because the figure of Lacépède ("La Murene Myre"), on which *Muræna longicollis* was founded, by no means represents a *Myrophis*, and was more likely intended for *Echelus myrus*. We are also convinced that the forms called *microstigmius* and *lumbricus* are but individual variations of *Myrophis punctatus*.

85. MYROPHIS VAFER.

Myrophis vafer Jordan & Gilbert, Proc. U. S. Nat. Mus., 645, 1882 (Panama); Jordan, Proc. U. S. Nat. Mus., 370, 1885 (Panama; Guaymas).

Habitat: Pacific coast of tropical America.

Etymology: Latin, *vafer*, subtle or sly.

This species is close to *M. punctatus*, which it represents on the Pacific coast. The larger pectoral, however, at once distinguishes *vafer* from *punctatus*. The specimens before us are from the Gulf of California, collected by Dr. Gilbert.

Genus 22.—PARAMYRUS.

Paramyrus Günther, Cat. Fish. Brit. Mus., VIII, 51, 1870 (*cylindroideus*).

Type: *Conger cylindroideus* Ranzani.

Etymology: *Παρά*, near; *Myrus*=*Echelus*.

This genus, a near relative of *Echelus*, contains one American and one Asiatic species.

ANALYSIS OF THE AMERICAN SPECIES OF PARAMYRUS.

a. [Dorsal fin commencing nearly above the middle of pectorals; tail twice as long as head and trunk; vertical fins with a narrow black edge.] (*Ranzani.*)
CYLINDROIDEUS, 86.

86. PARAMYRUS CYLINDROIDEUS.

Conger cylindroideus Ranzani, Nov. Spec. Pisc. Diss. Prima, 80, pl. 13, fig. 2, 1838 (Brazil).

Paramyrus cylindroideus Günther, VIII, 51, 1870 (copied).

Habitat: Coast of Brazil.

Etymology: *Κύλινδρος*, cylinder; *εἶδος*, like.

This species is known only from Ranzani's description and figure.

Genus 23.—ECHELUS.

Echelus Rafinesque, Caratteri di Alcuni Generi., 64, 1810 (in part, includes species of *Conger*, *Ophisoma*, etc.).
Myrus Kaup, Apodes 31, 1856, (*vulgaris*=*myrus*).
Echelus Bleeker, Atlas Ichth. Murènes, 30, 1864 (*myrus*).

Type: *Echelus punctatus* Rafinesque=*Murœna myrus* L. (as restricted by Bleeker).

Etymology: *Ἔγχελυς*, eel, properly spelled *Enchelys*.

This genus contains two species, both of the eastern Atlantic, eels of larger size than the others of the family.

We follow Bleeker in using the name *Echelus* instead of *Myrus*. The genus *Echelus* as originally proposed included species of *Leptocephalus*, *Ophisoma*, *Ophisurus*, and *Myrus*. It has priority over *Ophisoma* and *Myrus*, of which *Myrus* is the more recent.

ANALYSIS OF THE SPECIES OF ECHELUS.

a. [Pectoral long, $2\frac{2}{5}$ in head; dorsal fin commencing behind tip of pectoral; body elongate; tail $\frac{2}{3}$ of total length; head $4\frac{1}{3}$ in the trunk; eye 2 in the snout, which is 3 in the head; cleft of mouth extending behind hinder margin of eye; dorsal inserted as much behind gill-openings as gill-openings are behind the eye; lateral line distinct. Color gray; fins paler; gill-openings black.] (*Vaillant*). PACHYRHYNCHUS, 87.

aa. Pectoral moderate, $3\frac{1}{2}$ in the head; dorsal commencing a little in front of the top of the pectoral; head $2\frac{2}{3}$ in the trunk, 5 in the tail; eye $1\frac{1}{2}$ in the snout, which is a little more than 4 in the head; gape of mouth 3 in the head, extending almost to the hinder margin of the eye; gill-openings 2 in the isthmus. Uniform brown, darker on the opercular regions; two rows of small light-colored spots extend from the front of the dorsal fin forwards; a light band across the head, in front of which are several other shorter bands, running both longitudinally and transversely; snout with several small, irregular, whitish blotches; vertical fins posteriorly, with the edge darkest; gill-openings light-colored...MYRUS, 88.

87. ECHELUS PACHYRHYNCHUS.

Myrus pachyrhynchus Vaillant, Exp. Travailleur et Talisman, 81, pl. v, fig. 1, 1*a*, 1*b*, 1888 (Morocco; Cape Verde Islands).

Habitat: Deep waters of the Mediterranean and adjacent seas.

Etymology: *Παχύς*, thick; *ῥύγχος*, snout.

This species is known from the account given by Vaillant.

88. ECHELUS MYRUS.

Serpens marinus alter Willughby, 108, 1686 (Mediterranean Sea).
Murœna rostro acuto Artedi, Genera, 1738 (based on Willughby).
Murœna myrus Linnæus, Syst. Nat., ed. x, 225 (based on Artedi and of the copyists).
La murœna myre Lacépède, Hist. Nat. Poiss., II, pl. 3, fig. 3, 1798.
Echelus punctatus Rafinesque, Caratteri, 65, 1810 (Sicily).
Murœna longicollis Cuvier, Règne Animal, 313, 1828 (no description; based on Lacépède).
Myrus vulgaris Kaup, Apodes, 31, fig. 14, 1856; Günther, VIII, 50, 1870, and of European writers generally.

Habitat: Mediterranean Sea.

Etymology: Μῦρος, *Myrus*, the ancient name of the species.

This species is not rare in the Mediterranean; we have a single specimen from Palermo. It reaches a larger size than the other members of the family.

Family IV.—MURÆNESOCIDÆ.

This family as here understood comprises those scaleless Anguilloid eels which have the posterior nostril not labial, the tongue largely adnate, the jaws not excessively elongate, the end of the tail surrounded by the caudal fin, and the pectoral fins well developed. None of these characters appear to have in themselves great importance, but according to Dr. Gill, in the genus *Murænesox*, the only genus in which the osteology is well known, the characters are such as fully to justify family distinction. Dr. Gill gives the following:

DIAGNOSIS OF MURÆNESOCIDÆ.

Enchelycephalous apodals with the tongue not free, the branchiostegal membrane connecting the opposite sides below, the epipharyngeals reduced to one pair, and the hypopharyngeals linguiform and encroaching on the fourth branchial arch.

To this should be added: Gill-openings rather wide; pectoral fins well developed; jaws of moderate length; vomer well armed.

Whether all these characters are found in the other genera commonly associated with *Murænesox* is not yet known. The family seems divisible into two well-marked groups, which are perhaps as distinct from each other as from the *Echelidæ* or the *Congridæ*. The *Nettastominæ*, usually associated with *Murænesox*, we have removed to form a distinct group near the *Nemichthyidæ*.

The species of this family are not very numerous, and a large proportion are American. In general appearance and habits they approach the Congers. All are plainly colored and some descend to rather deep water.

ANALYSIS OF AMERICAN GENERA OF MURÆNESOCIDÆ.

a. Dorsal and anal fins low anteriorly, developed chiefly on the tail. (STILBISCINÆ).
- *b.* Tail short, little more than half as long as rest of body; teeth all uniserial, unequal, some of them canine-like; body very slender, whip-shaped.
  - *c.* Dorsal fin beginning close behind the nape.............. GORDIICHTHYS, 24.
  - *cc.* Dorsal fin beginning behind the vent...................... STILBISCUS, 25.
- *bb.* Tail about as long as rest of body; teeth moderate; dorsal beginning before the vent.
  - *d.* Body whip-shaped, the diameter less than one-fiftieth the length; dorsal beginning not far behind pectoral................ LEPTOCONGER, 26.
  - *dd.* Body moderately elongate, the diameter more than one-thirtieth the length; dorsal beginning just before vent.................. NEOCONGER, 27.

aa. Dorsal and anal fins well developed throughout, the dorsal beginning nearly above gill-opening; snout moderately produced; vomerine teeth very strong. (MURÆNESOCINÆ.)

e. Teeth in jaws biserial, small; vomer with a series of long, pointed canines; tail about 4 times as long as rest of body; gill-openings narrow. HOPLUNNIS, 28.

ee. Teeth in jaws in several series; gill-openings wide.

f. Teeth in jaws in several series, those of one series enlarged and compressed, long canines in front; vomer with several long series of teeth, the middle one of conical canines .... MURÆNESOX, 29.

ff. Teeth all conical, slender, and sharp, those of jaws in wide bands; maxillary with deep groove, running the entire length of the bone and dividing the band of teeth into two portions; shaft of vomer with a medial series of conical teeth .... XENOMYSTAX, 30.

Genus 24.—GORDIICHTHYS.

Gordiichthys Jordan & Davis, gen. nov. (*irretitus*).

Type: *Gordiichthys irretitus* Jordan & Davis.

Etymology: *Gordius*, a horse-hair worm, from Γόρδιος, the king whose complicated knot was cut by Alexander; ἰχθύς, fish.

This genus is based on a single species, distinguished from *Stilbiscus* by the position of its dorsal.

ANALYSIS OF SPECIES OF GORDIICHTHYS.

a. Dorsal fin beginning before the gill-opening, not far behind the nape; trunk very long; tail $1\frac{3}{5}$ in rest of body; head about 16 in trunk (15 to 18, the type being so injured that the gill-openings can not be made out); greatest depth of body 40 to 50 times in length of body; upper jaw much the longer, arched, the eye behind its middle; eye moderate, $2\frac{1}{2}$ in snout, $4\frac{1}{2}$ in gape; lower jaw with one row of about 10 stoutish recurved teeth on each side, those in front enlarged and canine-like; upper jaw with a series of similar teeth on each side and another down middle of vomer, these three series converging forward and meeting at a point opposite middle of lower jaw; in front of this on premaxillary and nasal bones about 4 large, stout, hooked canines, the largest teeth of all; 123 vertebræ in trunk (probably about 100 in tail); (pectoral, gill-opening, and skin wholly digested in the type; coloration probably similar to *Stilbiscus edwardsi*). IRRETITUS, 89.

89. GORDIICHTHYS IRRETITUS.

Gordiichthys irretitus Jordan & Davis, sp. nov. (Snapper Banks at Pensacola).

Habitat: Gulf of Mexico.

Etymology: *Irretitus*, entangled.

This species is known from a single partly digested example, 31 inches long, from the spewings of snappers (*Lutjanus aya*) on the Snapper Banks at Pensacola.

Genus 25.—STILBISCUS.

Stilbiscus Jordan & Bollman, Proc. U. S. Nat. Mus., 549, 1888 (*edwardsi*).

Type: *Stilbiscus edwardsi* Jordan & Bollman.

Etymology: Στίλβω, to shine.

This genus contains a single species, a very slender eel, distinguished from *Leptoconger* by its short tail.

ANALYSIS OF SPECIES OF STILBISCUS.

a. Head $7\frac{1}{2}$ in trunk, $4\frac{1}{2}$ in tail; snout 7 in head, its length somewhat greater than distance between gill-openings; eye $1\frac{4}{5}$ in snout, $1\frac{1}{2}$ in interorbital space; cleft of mouth reaching to posterior margin of eye; upper jaw 5 in head; height of gill-opening $1\frac{1}{2}$ in snout; teeth all uniserial, some of the anterior enlarged, canine-like; dorsal beginning $1\frac{2}{3}$ length of head behind vent; length of first part about equal to head and pectoral; developed part of dorsal at tail contained $1\frac{2}{3}$ times in the head; pectoral 6 in head. Upper part of head and body above lateral line brown; lower parts bright metallic-bluish silvery; dorsal and anal pale, the latter with a dusky stripe on each side of its base; pectorals dusky; caudal black..EDWARDSI, 90.

90. STILBISCUS EDWARDSI.

Stilbiscus edwardsi Jordan & Bollman, Proc. U. S. Nat. Mus., 549, 1888 (Green Turtle Cay, Bahama Islands).

Habitat: West Indian fauna.

Etymology: Named for Charles Lincoln Edwards.

This species is known from a single specimen taken by Dr. C. L. Edwards at Green Turtle Cay, one of the Bahama Islands.

Genus 26.—LEPTOCONGER.

Leptoconger Poey, Anales Hist. Nat. Esp., 250, 1880 (*perlongus*).

Type: *Neoconger perlongus* Poey.

Etymology: *Λεπτός*, slender; Conger.

This genus is based on a single species, a little-known eel of the West Indian fauna. It is very close to *Neoconger*, from which it differs mainly in the very slender body.

ANALYSIS OF SPECIES OF LEPTOCONGER.

a. [Head 4 in trunk; tail about a third longer than rest of body; gape 4 in head; eye large, $1\frac{3}{4}$ in snout; snout pointed; teeth hooked, short and robust, subequal and uniserial, a few in front enlarged; lower jaw much shorter than upper; dorsal beginning just behind tip of pectoral. Violet brown, pale below; dark points over the entire surface.] (*Poey*..............................PERLONGUS, 91.

91. LEPTOCONGER PERLONGUS.

Neoconger perlongus Poey, Ann. Lyc. Nat. Hist. N. Y., 67, tab. 9, fig. 3–4, 1874 (Matanzas).

Leptoconger perlongus Poey, Ann. Hist. Nat. Esp., 250, 1880 (Matanzas).

Habitat: West Indian fauna.

Etymology: Latin, *perlongus*, very long.

This species is known only from Poey's description.

Genus 27.—NEOCONGER.

Neoconger Girard, U. S. Mex. Bound. Surv., Ichth., 77, 1859 (*Mucronatus*).

Type: *Neoconger mucronatus* Girard.

Etymology: *Νεός*, new; Conger.

This genus, like the two preceding, is composed of small eels inhabiting considerable depths of water. Two species are known.

ANALYSIS OF THE SPECIES OF NEOCONGER.

a. [Pectoral small. Dark reddish brown above, paler below; head small, slender, pointed; upper jaw the longer; dorsal fin beginning just in front of the vent, forming a membranous ridge until near the tail, where it expands and becomes fin-like.] (*Girard*) ....MUCRONATUS, 92.

aa. Pectoral well developed, $3\frac{1}{2}$ to 4 in head. Snout anteriorly short, slightly projecting beyond mouth; mouth small, reaching slightly behind eye; teeth small, conical, uniserial in jaws, biserial anteriorly on the vomer, uniserial posteriorly; gill-slits vertical, longer than eye, a little longer than isthmus; dorsal beginning half the length of the head in advance of the vent; body not very slender, its depth $2\frac{1}{2}$ in head; head $3\frac{1}{5}$ in trunk; cleft of mouth $3\frac{1}{2}$ in head; tail usually a little longer than the rest of body; tip of tongue slightly free. Color uniform, yellowish-olive on body and fins, finely dotted with black ....VERMIFORMIS, 93.

92. NEOCONGER MUCRONATUS.

Neoconger mucronatus Girard, U. S. Mex. Bound. Surv., 77, 1859 (St. Joseph Isl., Texas); Günther, VIII, 49, 1870 (copied); Goode & Bean, Proc. U. S. Nat. Mus., 155, 1879; Jordan & Gilbert, Syn. Fish. N. A., 360, 1883 (copied).

Habitat: Gulf of Mexico.

Etymology: Latin, *mucronatus*.

This species is known only from the indifferent description given by Dr. Girard. A second specimen from West Florida is said to be in the National Museum, but we have not seen it, and no description has been published. The descriptions are not sufficient to distinguish the species from *Neoconger vermiformis*.

93. NEOCONGER VERMIFORMIS.

Neoconger vermiformis Gilbert, Proc. U. S. Nat. Mus., 57, 1890 (station 3035, Lower California).

Habitat: Pacific coast of Mexico.

Etymology: Latin, *vermis*, worm; *forma*, shape.

This species is known from several specimens, the largest 6 inches long, taken by Dr. Gilbert at station 3035, off the coast of Lower California, at a depth of 30 fathoms. An additional specimen, from station 2799 off Panama, has been since received; this is considerably larger than the types and has the pectorals shorter (somewhat worn at the end), scarcely $\frac{1}{4}$ length of head. The specimen agrees in other respects with *N. vermiformis*, and is probably of the same species.

Genus 28.—HOPLUNNIS.

Hoplunnis Kaup, Aale Hamburg. Museum, 19, 1859, (*schmidtii.*)

Type: *Hoplunnis schmidtii*, Kaup.

Etymology: Ὅπλον, armature; ὕννις, vomer; correctly written *Hoplynnis*.

This genus contains a single species.

ANALYSIS OF THE SPECIES OF HOPLUNNIS.

a. [Tail about four times as long as rest of body; eye 3 in snout; posterior portion of vertical fins black.] (*Kaup* per *Günther*) .... SCHMIDTII, 94.

94. HOPLUNNIS SCHMIDTII.

Hoplunnis schmidtii Kaup, Aale Hamb. Mus., 19, taf. 2, fig. 4, 1859 (Puerto Cabello) (*fide* Günther); Günther, VIII, 49, 1870.

Habitat: Atlantic coast of Central America.

Etymology: A personal name.

This species is known to us only from Kaup's account as quoted by Dr. Günther

Genus 29.—MURÆNESOX.

Murænesox McClelland, Calcutta Journ. Nat. Hist., IV, 408, 1843 (*cinereus*).
Cynoponticus Costa, Fauna Napoli Pesci., 1850, tav. 28 (*ferox* = *savanna*).
Brachyconger Bleeker, Nederl. Tidsskr. Dierkunde, II, 233, 1865 (*savanna*).
Congresox Gill, Proc. U. S. Nat. Mus., 234, 1890 (*talabon*).

Type: *Muræna cinerea* Forskål.

Etymology: *Muræna; esox*, pike.

This genus contains numerous species, large, conger-like eels, some of which are found in all warm seas. They are remarkable for the strong armature of the vomer.

There seems to be no doubt that the group called *Cynoponticus* and *Brachyconger* is generically identical with the type of *Murænesox*, but the group called *Congresox*, from the East Indies, having the vomerine teeth acutely conic, is somewhat different, and should perhaps be recognized as a distinct genus.

ANALYSIS OF THE AMERICAN SPECIES OF MURÆNESOX.

a. Median teeth on vomer enlarged, compressed, cultrate; median teeth on side of lower jaw also enlarged and compressed or bluntish. (MURÆNESOX.)

b. Middle series of teeth on vomer not distinctly tricuspidate; pectoral rather more than half head; vomer with a median row of about 15 very large, strong teeth, which are much compressed, the tip angular and directed backwards, and with a nick on the posterior edge, thus ; one or two of the anterior teeth only slightly tricuspidate; on each side of the median row on vomer some very small, blunt teeth, disappearing anteriorly, arranged in one or two rows very close to the median row; jaws with one or two outer rows of small, blunt teeth, next a row of rather large, wedge-shaped teeth, and then an inner band of small, conical, blunt teeth in two, three, or four series; front of both jaws with groups of canines, which are shorter than the pupil of the eye; in old examples the teeth, especially those on the vomer, are often so worn that their original form is not at all evident; head 2 in trunk, $3\frac{3}{4}$ in tail; pectoral fin twice in the distance between the tip of snout and the base of the fin; eye $2\frac{1}{3}$ in the snout, $1\frac{1}{2}$ in interorbital width, $3\frac{1}{2}$ in cleft of mouth, situated a little behind middle of gape; cleft of mouth $2\frac{1}{2}$ in the head; gill-opening large, containing the isthmus twice; dorsal beginning over the gill-openings. Olive brown above, dull whitish below; dorsal and anal light brown with a dark margin; caudal and pectoral fins black .. CONICEPS, 95.

bb. Median series of teeth on vomer distinctly tricuspidate in the young, becoming entire with age, with nearly even surface, thus,  ; pectoral as long as maxillary, $2\frac{2}{3}$ in head; eye 2 in snout, which is $4\frac{1}{2}$ in head; dorsal inserted over the gill-opening. Brown above, silvery below; dorsal and anal edged with black.

SAVANNA, 96.

95. MURÆNESOX CONICEPS.

Murænesox coniceps Jordan & Gilbert, Proc. U. S. Nat. Mus., 348, 1881 (Mazatlan); Jordan, Cat. Fish. N. A., 55, 1885.

Habitat: Pacific coast of tropical America, Mazatlan to Panama.

Etymology: Latin, *conus*, cone; *ceps*, headed.

This species is generally common on the Pacific coast of tropical America, where it reaches a length of 2 or 3 feet. Our specimens are from Mazatlan, Panama, and off the coast of Colombia.

The species is very close to the next, and the difference in dentition, well marked in young examples, seems to be wholly lost in the adult.

96. MURÆNESOX SAVANNA.

Murænesox savanna Cuvier, Règne Animal, 1828 (name only) ("La Savanne de Martinique").

Conger savanna Bennett, Proc. Comm. Zööl. Soc., 135, 1831 (*fide* Günther).

Murænesox savanna Kaup, Apodes, 117, fig. 74, 1856 (South America); Günther, VIII, 47, 1870.

Brachyconger savanna Bleeker, Atlas des Murènes Indes Orient., IV, 20, 1864 (generic diagnosis).

Conger brasiliensis Ranzani, Nov. Spec. Pisc. Diss. Prima., IV, 17, tab. 13, fig. 1, 1838 (Brazil).

Cynoponticus ferox Costa, Fauna Napoli Pesc., tab. 28, 1850 (Naples) (*fide* Günther).

Congrus curvidens Richardson, Voy. Erebus and Terror, III, 1845 (no habitat); Kaup, Apodes, 117, 1856.

Conger limbatus Castelnau, Anim. Amer. Sud, 83, pl. 43, fig. 3, 1855 (Rio Janeiro).

Habitat: West Indian fauna from Cuba to Rio Janeiro; also occasional in the Mediterranean Sea.

Etymology: From the local name "Savanne," at Martinique.

We follow Günther in referring all the nominal species of *Murænesox* found in the Atlantic to the synonymy of *Murænesox savanna*. The specimen examined by us is from Bahia. The variations due to age in the form of large teeth on the vomer are very considerable.

Genus 30.—XENOMYSTAX.

Xenomystax Gilbert, MSS. (*atrarius*).

Type: *Xenomystax atrarius* Gilbert.

Etymology: Ξενός, strange; μύσταξ, maxilla.

This genus, which is allied to *Murænesox*, is thus described by Dr. Gilbert:

Scaleless; pectorals well developed; vertical fins large, continuous around the tail, the rays evident; dorsal beginning before base of pectorals. Gill-slits vertical and rather wide, the gill membrane continuous below the throat. Branchiostegals

apparently 11 or 12 in number, long and much curved, continuing around the posterior and upper edges of the opercles; mouth with wide lateral cleft, not extending far beyond eye; maxillaries very wide, not extending far forwards, the clasping processes applied to shaft of vomer well behind its head. Teeth all conical, slender, and sharp, mostly depressible, those in jaws in wide bands; maxillary with a deep lengthwise groove, running the entire length of the bone and dividing the band of teeth into two portions; lower jaw much shorter than upper. Posterior nostril a linear slit, midway between eye and tip of snout; the anterior is a short tube just behind the head of vomer; tongue small, with the tip free; lips undeveloped; the lateral line conspicuous.

ANALYSIS OF THE SPECIES OF XENOMYSTAX.

a. [Snout very long and slender; end of maxillary equidistant from tip of mandible and gill-opening; front of orbit over the beginning of last third of gape; long slit-like pores on margin of upper jaw, a conspicuous series on mandible and preopercle; teeth in jaws in wide bands, mostly depressible; maxillary teeth divided by a deep groove running entire length of jaw, those on inner side of groove long, close-set, rigid, in single series; mandible with much narrower and shallower groove, on the inner edge of which is a single series of very small conical teeth, directed inwards; tip of mandible enlarged to form a knob which fits into a toothless depression just behind head of vomer, the vomer extending well beyond the tip of lower jaw; teeth on head of vomer and knob of mandible similar, slightly larger than those of side of jaw; anterior part of shaft of vomer with median series of strong conical teeth, accompanied by smaller lateral series and followed by a narrower band of very small conical teeth. Head equal to trunk and $\frac{1}{3}$ of tail; gill-openings broadly lunate, vertical length of slit $\frac{1}{3}$ of snout, interspace $\frac{2}{3}$ length of slit; pectorals narrow, $\frac{1}{2}$ snout. Color very dark brown; fins black; pores of lateral line white.] (*Gilbert*) .... ATRARIUS, 97.

97. XENOMYSTAX ATRARIUS.

Xenomystax atrarius Gilbert, MSS. (off coast of Ecuador).

Habitat: Deep waters of the eastern Pacific.

Etymology: *Atrarius*, blackish.

A single specimen, $18\frac{3}{4}$ inches long, was taken by the *Albatross* off the west coast of Ecuador at about lat. 1° S., long. 81° W., 401 fathoms.

Family V.—NETTASTOMIDÆ.

This family, as understood by us, contains a few species of deep-sea eels closely allied to the *Murænesocidæ* in technical characters, but more resembling the *Nemichthyidæ* in appearance, form of the head, and in dentition. The family, which is a provisional one, may be thus defined:

Enchelycephalous eels without pectoral fins, with the tongue not free, the posterior nostrils remote from the lip, the gill-openings small, separate, and subinferior, the vent remote from the head, the tail ending in a slender tip or filament, the dorsal and anal fins moderately developed, and the jaws produced, slender, and straight, the upper the longer, and both, as also the vomer, armed with bands of sharp, close-set, recurved, subequal teeth.

Three genera are known, deep-sea fishes with fragile bodies and the thin skin charged with black pigment.

ANALYSIS OF GENERA OF NETTASTOMIDÆ.

a. Dorsal fin low, beginning nearly above gill-opening.
b. Nostrils lateral, the posterior slit-like and placed just in front of eye; snout without fleshy tip .... CHLOPSIS, 31.
bb. Nostrils nearly superior, the posterior above and in front of eye, the anterior at tip of bony portion of snout; head with numerous mucous pores.
c. Snout without a fleshy proboscis, the anterior nostrils near its tip. NETTASTOMA, 32.
cc. Snout with a long, slender, fleshy tip or proboscis, at the base of which are the anterior nostrils .... VENEFICA, 33.

Genus 31.—CHLOPSIS.

Chlopsis Rafinesque, Indice Ittiol. Sicil., 58, 1810 (*bicolor*).
Saurenchelys Peters, Berliner Monatsberichte, 397, 1864 (*cancrivora*).

Type: *Chlopsis bicolor* Rafinesque.

Etymology: Χλόη, a green twig; ὄψις, appearance.

This genus is based on a single little-known species from the Mediterranean to which another has been recently added. It is not very different from *Nettastoma*, apparently differing in the position of the nostrils.

ANALYSIS OF THE SPECIES OF CHLOPSIS.

a. (Head $2\frac{1}{5}$ in head and trunk; eye $\frac{1}{3}$ length of snout; upper jaw the longer; vertical fins with a black margin posteriorly; peritoneum silvery.) (*Peters*, per *Günther*) .... BICOLOR, 98.
aa. [Head $2\frac{3}{5}$ in head and trunk; eye $3\frac{1}{2}$ in snout; body extremely slender, tapering posteriorly to a very narrow tail, which is, however, not filamentous; head long and slender, lower jaw shorter than the upper; eye nearly over angle of mouth; posterior nostril a long horizontal slit immediately in front of lower margin of eye; series of slit-like mucous pores along upper jaw; series of round pores along lower jaw; transverse series on occiput; both jaws and vomer with wide bands of short, sharp conical teeth, inner series on jaws slightly longer than the other; bands on shaft of vomer reaching back to front of posterior nostril; gill-openings with their margins much curved, forming $\frac{4}{5}$ of a circle, their vertical diameter nearly equal to that of eye, and more than twice the length of the interspace; gape $2\frac{3}{5}$ in head; head $2\frac{3}{5}$ in head and trunk; body $3\frac{1}{4}$ in tail; eye $3\frac{1}{2}$ in snout; dorsal beginning $1\frac{1}{2}$ length of head behind the same. Color dusky-olive, dotted with coarse brown specks everywhere except on under side of head and fins; blackish streak on median line of belly; fins translucent.] (*Gilbert.*) EQUATORIALIS, 99.

98. CHLOPSIS BICOLOR.

Chlopsis bicolor Rafinesque, Indice Ittiol. Sicil., 59, 1810 (Palermo).
Saurenchelys cancrivora Peters, Monatsber. Akad. Wiss. Berl., 397, 1864 (Mediterranean) (*fide* Günther); Günther, VIII, 48, 1890 (copied).

Habitat: Mediterranean Sea.

Etymology: Latin, two-colored.

This species is known to us only from the scanty description of Peters. The equally scanty description and poor figure given by Rafinesque of his *Chlopsis bicolor* seems to belong to the same species, and we have therefore substituted Rafinesque's name for the preferable name given by Peters.

99. CHLOPSIS EQUATORIALIS.

Chlopsis equatorialis Gilbert, MSS.

Habitat: Deep waters of eastern Pacific.

Etymology: From the equator.

[This species has not the appearance of a deep-sea eel, though the intestine protruded through the anus in the type specimen, as the result of the release of pressure. It is described from a single specimen, 14½ inches long, taken by the *Albatross* off the coast of Ecuador at about lat. 1° S., long. 81° W., in 401 fathoms.] (*Gilbert.*)

Genus 32.—NETTASTOMA.

Nettastoma Rafinesque, Caratteri, etc., 66, 1810 (*melanurum*).

Hyoprorus Kölliker, Verh. Phys. Med. Ges. Wurzb., IV, 101, 1854 (*messinensis* = larva of *melanurum*).

Type: *Nettastoma melanurum* Rafinesque.

Etymology: *Νῆττα*, duck; *στόμα*, mouth.

This genus contains two or three species from the deeper parts of both oceans.

ANALYSIS OF EUROPEAN SPECIES OF NETTASTOMA.

a. (Cleft of the mouth extending to below the hind margin of eye; dorsal fin commencing immediately behind the gill-openings; tail long, nearly twice as long as body; fins with a black margin posteriorly; peritoneum black.) (*Günther.*) MELANURUM, 100.

100. NETTASTOMA MELANURUM.

(SORCIÈRE.)

Nettastoma melanurum Rafinesque, Caratteri, 66, 1810 (Sicily); Günther, VIII, 48, 1870 (Nice); Doderlein, Atti. Acc. Soc. 58, 1877 (Palermo); Giglioli, Cat. Anfib. e Pesci Ital., 47, 1880 (Nice, Palermo); Vinciguerra, Ann. Mus. Civ. St. Nat. Genova, 585, 1883; Günther, Voy. Challenger, XXII, 253, 1887, and of European writers generally.

Murænophis saga Risso, Ichth. Nice, 370, pl. 10, fig. 39, 1810 (Nice).

Hyoprorus messinensis Kölliker, Verh. Phys. Med. Gesellschs. Würzburg, IV, 101, 1854 (Messina; larval form); Vaillant, Expéd. Travailleur et Talisman, 95 (Morocco).

? *Nettastoma brevirostre* Facciolá, "Nat. Sicil., VI, 166, pl. III, f. 3, Sicily," 1887 (*fide* Zoölogical Record).

Habitat: Mediterranean Sea.

Etymology: *Μελάς*, black; *οὐρά*, tail.

This species is not rare in the deeper parts of the Mediterranean. According to Risso, its flesh has a disagreeable odor. Another species, *Nettastoma brevirostre* Facciolá, has been described from the Mediterranean, but we have not seen the description.

Genus 33.—VENEFICA.

Venifica Jordan & Davis, gen. nov. (*procerum*).

Type: *Nettastoma procerum* Goode & Bean.

Etymology: *Venefica*, sorceress, from the name *Sorcière* used at Nice for *Nettastoma melanurum*.

This genus contains two known species, from the depths of the Atlantic and Pacific Oceans. They differ from *Nettastoma* only in the presence of a fleshy tip to the snout.

ANALYSIS OF SPECIES OF VENEFICA.

a. [Tail twice as long as head and trunk; body very elongate, compressed, especially so posteriorly; head slender, conical; upper jaw projecting an eye's diameter beyond the chin; beyond this a slender, fleshy, proboscis-like tip, whose length is twice that of the eye; snout a little more than 2 in the head; anal fin beginning at a distance from the snout, equal to $2\frac{3}{5}$ times the length of the head; tail twice as long as rest of body, the head included. Color, dark brownish; peritoneum black.] (*Goode & Bean.*)................................PROCERA, 101.

aa. (Tail a little longer than head and trunk; nasal proboscis a flat, triangular projection half the length of snout, resembling the snout of the snake "Porte-épée," *Langaha ensifera*; teeth fine, in cardiform bands on jaws and palate; gill-openings near together; dorsal inserted nearly over the gill-openings; tail a little more than one-half the total length; head 10 in total length. Color, brown or almost black.] (*Vaillant.*)................................PROBOSCIDEA, 102.

101. VENEFICA PROCERA.

Nettastoma procerum Goode & Bean, Bull. Mus. Comp. Zoöl., x, 5, 224, 1883 (Atlantic Ocean, lat. 33° 35′ to 40° N., long. 76° W.; depth, 178 to 647 fathoms). Günther, Voy. Challenger, XXII, 253, 1887 (copied).

Habitat: Depths of the Atlantic.

Etymology: *Procerus*, elongate.

This species is known from three specimens obtained by the *Albatross* in the Gulf Stream off the coast of North Carolina.

102. VENEFICA PROBOSCIDEA.

Nettastoma proboscideum Vaillant, Expéd. Travailleur et Talisman, 84, 1888 (Morocco).

Habitat: Deep waters of the Mediterranean.

Etymology: Latin, having a proboscis.

The type of this species is from near Morocco.

Family VI.—NEMICHTHYIDÆ.

(THE THREAD EELS.)

This family includes eels with the body attenuate and the jaws very slender, needle-like, and more or less recurved at tips. There are no scales; the gill-openings are separate or partly confluent; the pectoral fins are well developed (in our species, wanting in the East Indian genus *Gavialiceps*), as well as the dorsal and anal, and the nostrils are near together, in front of eye, without tube or flap.

These eels inhabit the deep seas; the species are little known and the anatomy has never been studied. Judging from external characters, their nearest relations are with the *Nettastomidæ*, and possibly through them with the *Murænesocidæ*, but the connection of *Nettastoma* with *Murænesox* is very questionable.

ANALYSIS OF GENERA OF NEMICHTHYIDÆ.

a. Gill-openings partly confluent, rather large; vomerine teeth conspicuously enlarged.
b. Vomerine teeth lancet-shaped, very close set; jaws moderate, the snout not longer than rest of head; vent at a distance behind head about equal to postorbital part of head; eye above angle of mouth ....SERRIVOMER, 34.
bb. Vomerine teeth conical; jaws very long, attenuate; color silvery.
SPINIVOMER, 35.
aa. Gill-openings distinctly separate; vomerine teeth moderate; jaws excessively attenuate, the upper longer and recurved; tail probably always normally with a filiform tip; (truncate in injured specimens; short and band-like in translucent larvæ).
c. Vent remote from the head, at a distance behind pectoral more than 3 times length of that fin; color black.
d. Gill-slits very small, inferior, well separated; dorsal commencing above vent; (tail truncate); jaws moderate........................CYEMA, 36.
dd. Gill-slits lateral, vertical, well separated; dorsal commencing above pectorals; tail filamentous; jaws long and slender; a single series of pores along lateral line ....AVOCETTINA, 37.
cc. Vent at the throat, at a distance behind the head less than length of pectoral; anal fin beginning below middle of pectorals; body very long and slender, most of the dorsal rays very slender, nearly free, appearing like slender spines; jaws very slender, not expanded at tip.
e. (Tail truncate, the result of mutilation?); a single row of pores along lateral line; color black ....LABICHTHYS, 38.
ee. Tail always ending in a long filament; two or three rows of pores along lateral line; color dusky silvery, darker below ....NEMICHTHYS, 39.

Genus 34.—SERRIVOMER.

Serrivomer Gill & Ryder, Proc. U. S. Nat. Mus., 260, 1883 (*beani*).

Type: *Serrivomer beani* Gill & Ryder.

Etymology: Latin, *serra*, saw; *vomer*.

This genus contains a single species, from the deep waters of the Atlantic.

ANALYSIS OF THE SPECIES OF SERRIVOMER.

a. [Stoutest of the family, with much shorter jaws than any other, and with a very formidable vomerine armature; depth of head at vertical from mandibular articulation contained 37 times in the total length; greatest height 29⅘ in total length.] (*Gill & Ryder*) ....BEANI, 103.

103. SERRIVOMER BEANI.

Serrivomer beani Gill & Ryder, Proc. U. S. Nat. Mus., 261, 1883 (Atlantic).

Habitat: Atlantic Ocean (lat. 41° 40′ 30″, long. 65° 28′ 30″).

Etymology: Named for Tarleton H. Bean.

This species is known from the brief description given by Dr. Gill.

Genus 35.—SPINIVOMER.

Spinivomer Gill & Ryder, Proc. U. S. Nat. Mus., 261, 1883 (*goodei*).

Type: *Spinivomer goodei* Gill & Ryder.

Etymology: Latin, *spinus*, spine; *vomer*.

This genus contains, so far as known, a single species from the deep sea.

ANALYSIS OF THE SPECIES OF SPINIVOMER.

a. [Silvery; recognizable also from its smaller eye and deeper mandibles, greatest height of body at the branchial regions contained 52 times in total length; rays ensheathed in a tough membrane.] (*Gill & Ryder*)................ GOODEI, 104.

104. SPINIVOMER GOODEI.

Spinivomer goodei Gill & Ryder, Proc. U. S. Nat. Mus., 261, 1883 (Atlantic).

Habitat: Atlantic Ocean (lat. 38° 19′ 26″, long. 68° 20′ 20″).

Etymology: Named for George Brown Goode.

This species was taken by the *Albatross* in the Atlantic.

Genus 36.—CYEMA.

Cyema Günther, Ann. & Mag. Nat. Hist. II, 251, 1878 (*atrum*).

Type: *Cyema atrum* Günther.

Etymology: *Κυῆμα*.

The name *Cyema* is based on a single species apparently allied to *Nemichthys* and still more closely to *Avocettina*, from which it differs in the more posterior position of the vent, in the form of the tail, which is not surrounded by a fin, and especially in the very small, inferior gill-slits. The peculiar soft band-like form of the body in *Cyema atrum* is probably not characteristic of the species when adult, the type being probably in a larval or leptocephalous stage.

ANALYSIS OF THE SPECIES OF CYEMA.

a. [Dorsal fin commencing nearly opposite the vent; body compressed, soft, and short; the depth contained 12 times in the body, the head not included; eye minute; upper jaw tapering into a very long, slender beak; teeth on jaws in broad bands; gill-openings very small, close together at the lower surface of the body, immediately in front of base of pectorals, at some distance from angle of lower jaw; vent midway between angle of mouth and end of tail; dorsal commencing nearly over vent; pectoral fin well developed, its distance from eye $\frac{2}{3}$ of that from vent. Coloration uniform black.] (*Günther*)............ATRUM, 105.

105. CYEMA ATRUM.

Cyema atrum Günther, Ann. & Mag. Nat. Hist., II, 251, 1887; Günther, Voy. Challenger, XXII, 265, pl. LIV, fig. D (South Pacific, 1500 fathoms; Antarctic Ocean, 1800 fathoms); Vaillant, Expéd. Travailleur et Talisman, 91, pl. 8, fig. 4, 1888 (coast of Morocco).

Habitat: Atlantic and Pacific in deep water.

Etymology: Latin, *ater*, black.

This singular fish is known only from the accounts given by Günther and Vaillant. It seems probable that its peculiar form is due to its imperfect development, and that it is a larval Nemichthyid.

Genus 37.—AVOCETTINA.

Avocettina Jordan & Davis, gen. nov. (*infans*).

Type: *Nemichthys infans* Günther.

Etymology: From *Avocetta*, the avocet or *Recurvirostra*.

This genus is based on a species allied to *Nemichthys*, but differing notably in the position of the vent. A second species, imperfectly known, is doubtfully assigned to the same group.

ANALYSIS OF THE SPECIES OF AVOCETTINA.

a. Eye rather large, contained 2 to 3 times in the distance between eye and pectoral; jaws long and filamentous, upper jaw 4 times the length of rest of head; both jaws covered with very fine recurved teeth; pectoral fin about as long as the head is high; gill-openings a little less than eye; postorbital part of head contained about 4 times in trunk; dorsal beginning over pectorals, consisting of very delicate rays; trunk contained at least 12 times in tail; greatest depth of body about equal to head without snout. Color uniform black, jaws lighter. INFANS, 106.

aa. [Eye minute; upper jaws short, scarcely as long as rest of head; trunk longer than head; tail with trunk $\frac{7}{9}$ of whole length.] (*Vaillant*) ...... RICHARDI, 107.

106. AVOCETTINA INFANS.

Nemichthys infans Günther, Ann. and Mag. Nat. Hist., 24, 1878 (mid-Atlantic 2,500 fathoms); Günther, Voyage Challenger, XXII, 264, 1884 (mid-Atlantic 2,500 fathoms; off Pernambuco 500 fathoms; Mona Channel, West Indies, 814 fathoms).

Labichthys gilli Bean, Proc. U. S. Nat. Mus., 45, 1890 (east of Prince of Wales Island, 56° 20′ N, 136° 20′ W, depth 1,569 fathoms).

Habitat: Deep waters of Atlantic and Pacific.

Etymology: Latin, *infans;* immature.

Our description is taken from a specimen collected by Dr. Gilbert on the west coast of Alaska. In Dr. Gilbert's opinion, the species called *gilli* is identical with *infans.*

107. AVOCETTINA RICHARDI.

Nemichthys infans Vaillant, Expéd. Trav. et Talis., 95, pl. VII, fig. 1, 1*a*, 1888 (Azores).

Nemichthys richardi Vaillant, op. cit., Appendix, 93, 1888.

Habitat: Deep water off the Azores.

Etymology: Named for M. Richard.

This species is known from the account given by Vaillant, based on an imperfect specimen.

Genus 38.—LABICHTHYS.

Labichthys Gill & Ryder, Proc. U. S. Nat. Mus., 261, 1883 (*carinatus*).

Type: *Labichthys carinatus* Gill & Ryder.

Etymology: λαβή, grip or hold, correlated with λάβις, forceps; ἰχθύς, fish.

This genus is based on two species from deep waters of the Atlantic. The scanty description does not show any important difference from *Nemichthys*, if we suppose, as is probable, that the truncate tail is the result of mutilation.

ANALYSIS OF THE SPECIES OF LABICHTHYS.

a. [The ridges that bound the median rostral groove converging and forming a carina along the median line in vertical from the anterior border of the orbit; greatest height $34\frac{1}{2}$ in total length. Color black.] (*Gill & Ryder.*) [Dorsal beginning over base of pectoral; vent close behind the pectorals]. (*Bean.*) ....CARINATUS, 108.

aa. [The ridges that bound the rostral groove not confluent backwards in a carina-form extension, but ending in a vertical from the orbit; greatest height of body 36 in a total length. Color black.] (*Gill & Ryder.*) ....ELONGATUS, 109.

108. LABICHTHYS CARINATUS.

Labichthys carinatus Gill & Ryder, Proc. U. S. Nat. Mus., 253, 255, 261, 1883 (Atlantic).

Habitat: Atlantic Ocean, lat. 41° 13′, long. 65° 33′ 30″.

Etymology: Latin, *carinatus*, keeled.

This species is known only from the scanty description of Gill & Ryder. According to Bean it agrees with *Nemichthys* in the position of its vent.

109. LABICHTHYS ELONGATUS.

Labichthys elongatus Gill & Ryder, Proc. U. S. Nat. Mus., 262, 1883 (Atlantic).

Habitat: Atlantic Ocean, lat. 39° 22′, long. 68° 34′ 30″.

Etymology: Latin, *elongatus*, elongate.

This species is known only from the original diagnosis. The position of the vent is not stated.

Genus 39.—NEMICHTHYS.

Nemichthys Richardson, Voyage Samarang, 16, 1848 (*scolopaceus*).
Leptorhynchus Lowe, Ann. Mag. Nat. Hist., x, 54, 1852 (*leuchtenbergi*) (preoccupied).
Belonopsis Brandt, Mém. Ac. St. Petersb., Savans Étrangers, 174, 1854 (*leuchtenbergi*).

Type: *Nemichthys scolopaceus* Richardson.

Etymology: *Νῆμα*, thread; *ἰχθύς*, fish.

This genus contains one or two species of long and very slender eels living in deep water, though perhaps nearer the surface than the members of related genera.

ANALYSIS OF THE AMERICAN SPECIES OF NEMICHTHYS.

a. (Head comparatively stout, its depth one-seventh its greatest length; eye moderate, less than one-third the length of head without snout; length of pectoral slightly less than height of anal. Pale above, belly and anal fin blackish, the color not abruptly changing; back somewhat speckled.).....SCOLOPACEUS, 110.

aa. Head slenderer, its depth one-ninth its greatest length; eye large, one-third the head without snout; length of pectoral scarcely greater than height of anal, head 12, depth 58, in total length. Translucent; belly with close-set dark spots; its lower edge and anal fin black, the back abruptly white and unspotted.
AVOCETTA, 111.

110. NEMICHTHYS SCOLOPACEUS.

Nemichthys scolopacea Richardson, Voy. Samarang, 25, 1848 (South Atlantic) (*fide* Günther); Günther, VIII, 21, 1870 (Madeira); Peters, Monatsber. Akad. Wiss., 849, 1876 (New Guinea); Goode & Bean, Bull. Essex Inst., 26, 1879 (George's Bank); Goode, Proc. U. S. Nat. Mus., 485, 1880 (south of coast of New England); Goode & Bean, Bull. Mus. Comp. Zoöl., 225, 1883; Jordan & Gilbert, Syn. Fish. N. A., 366, 1882; Günther, Voy. Challenger., XXII, 263, 1887 (Madeira).

Leptorhynchus leuchtenbergii Lowe, Mém. Soc. Savans Étrangers, Petersburg, 171, 1854 (Madeira).

Belonopsis leuchtenbergii Brandt, Mém. Soc. Sav. Étr., Petersb., 174, 1854 (with good plate) (Madeira).

Habitat: Deep waters of Atlantic.

Etymology: Latin, *scolopax*, snipe.

This species is not rare in the North Atlantic, large numbers having been taken with the trawl off the coast of New England.

111. NEMICHTHYS AVOCETTA.

Nemichthys avocetta Jordan & Gilbert, Proc. U. S. Nat. Mus., 409, 1880 (Puget Sound); Jordan & Gilbert, Proc. U. S. Nat. Mus., 37, 1881; Bean, ibid., 266 (Puget Sound); Jordan & Gilbert, Syn. Fish. N. A., 367, 1883; Günther, Voy. Challenger, XXII, 263, 1887 (copied).

Habitat: Pacific coast of United States.

Etymology: From the Avocet (*Recurvirostra*).

Of this species a single specimen, 22 inches long, is known. It was taken near Seattle on Puget Sound, swimming near the surface. Its movements in life were very active. It is not unlikely that this species will prove identical with *Nemichthys scolopaceus*, which it greatly resembles.

Family VII.—HETEROCONGRIDÆ.

This group consists of the single genus, *Heteroconger*. It appears to form a family distinct from the *Congridæ*, if the naked Enchelycephalous eels are not all to be referred to one family.

The genus is thus defined by Dr. Günther:

ANALYSIS OF GENERA OF HETEROCONGRIDÆ.

a. Body and especially tail exceedingly elongate, subcylindrical, scaleless; tail compressed; snout obtuse, very short, with the cleft of mouth obliquely ascending upwards, the lower jaw projecting beyond the upper; mouth small, extending to below front margin of the eye; teeth small, acicular, in narrow bands on the jaws and on the vomer; nostrils very small, in front of the eye; gill-openings lateral, narrow slits; pectoral none, vertical fins rather low; dorsal commencing at a short distance behind gill-opening..................... HETEROCONGER, 36.

Genus 40.—HETEROCONGER.

Heteroconger Bleeker, Versl. Med. Ak. Wet., Amsterdam, 331, 1868 (*polyzona*).

Type: *Heteroconger polyzona* Bleeker.

Etymology: Ἕτερος, different; Conger.

This singular genus contains two species, one from the East Indies, the other from the eastern Atlantic.

ANALYSIS OF THE SPECIES OF HETEROCONGER.

a. [Coloration uniform; head 5 in trunk; tail more than twice as long as head and trunk; eye small; vertical fins rather indistinct and low.] (*Günther.*) LONGISSIMUS, 112.

112. HETEROCONGER LONGISSIMUS.

Heteroconger longissimus Günther, VIII, 45, 1870 (Lanzarote, Canary Islands).

Habitat: Canary Islands.

Etymology: Latin, excessively long.

This species is known to us only from Günther's description.

Family VIII.—CONGRIDÆ.

(THE CONGER EELS.)

This family includes those eels which are scaleless, and have the tongue largely free in front, the body moderately elongate, the end of the tail surrounded by a fin, the posterior nostril remote from the upper lip and near front of eye, and the pectoral fins well developed. All the species are plainly colored, grayish or dusky above, silvery below, and the dorsal edged with black.

The three recognized genera are all represented within the limits of this paper. As, however, the osteology of most of the species is unknown, we can not say whether the *Murænesocidæ* and *Echelidæ* should really be separated from this group, or whether possibly *Heteroconger* should be included in it. Bleeker places all these genera with *Nettastoma* and *Nemichthys*, also in his family of *Congroidei*. Günther approximates *Conger* to *Anguilla*, while recognizing the allies of *Murænesox*, *Echelus*, *Heteroconger*, and *Nemichthys* as distinct subfamilies. *Nettastoma* he places with *Neoconger* and *Murænesox*.

ANALYSIS OF GENERA OF CONGRIDÆ.

a. Vomerine teeth uniserial, some of them canine-like; maxillary teeth biserial; dorsal beginning above root of pectoral; cleft of mouth extending beyond middle of eye; tail very long and slender, about half longer than rest of body. UROCONGER, 41.

aa. Vomerine teeth in bands, none of them canine-like; lips thick.

b. Dorsal fin beginning over the gill-opening; bones of front of head with large muciferous cavities; mouth rather small; jaws with bands of small teeth, the outer not forming a cutting edge; tail from half to two-thirds of total length. OPHISOMA, 42.

bb. Dorsal fin inserted at a point behind base of pectoral, but nearer pectoral than vent; head with inconspicuous mucous cavities; jaws with an outer series of close-set teeth forming a cutting edge; tail about half longer than rest of body. LEPTOCEPHALUS, 43.

Genus 41.—UROCONGER.

Uroconger Kaup, Apodes, 110, 1856 (*lepturus*).

Type: *Conger lepturus* Richardson.

Etymology: *Οὐρά*, tail; *Conger*.

This genus contains no American species.

ANALYSIS OF EUROPEAN SPECIES OF UROCONGER.

a. [Vomerine teeth large; two strong canines in front of vomer; lateral line distinct, with white points; cleft of mouth reaching the center of the eye; tail one-half longer than rest of body; pectoral fin 2½ in head; dorsal commencing over the tip of pectoral fin; body stouter than in *Uroconger lepturus*. Uniform brown.] (*Vaillant.*) ....VICINUS, 113.

113. UROCONGER VICINUS.

Uroconger vicinus Vaillant, Expéd. Travailleur et Talisman, 86, pl. VI, 1880–83 (Coast of Soudan, Arguin, Cape Verde Islands).

Habitat: Deep waters of the eastern Atlantic.

Etymology: Latin, *vicinus*, near (to *Uroconger lepturus*).

This species is known only from Vaillant's description and figure.

Genus 42.—OPHISOMA.

? *Ariosoma* Swainson, Nat. Hist. Classn. Fishes, II, 196, 1839 (no type mentioned).

Ophisoma Swainson, Nat. Hist. Classn. Fishes, II, 334, 1839 (*acuta*) not *Ophisomus* Swainson, l. c., p. 277=*Murænoides* Lacépède).

Conger-muræna Kaup, Apodes, 108, 1856 (*balearica*).

Gnathophis Kaup, Aale Hamb. Mus., 1859 (*heterognathus*).

Congromuræna Günther, VIII, 40, 1870 (*balearica*).

Ophisoma Bleeker, Poey, etc.

Type: *Ophisoma acuta* Swainson=*Muræna balearica* De la Roche.

Etymology: *Ὄφις*, snake; *σῶμα*, body.

This genus contains numerous species of small Congers, distinguished by the more anterior insertion of the dorsal and by the greater development of the muciferous cavities in the head. The species are very closely related and are therefore not well known.

The name *Ophisoma* was given by Swainson to two eels, *O. obtusa* and *O. acuta*, which are apparently identical with *Conger* and *Ophisoma balearicum*. The name was retained by Bleeker to the present group on the supposition that these eels belonged to the group called *Conger-muræna* by Kaup. It is therefore questionable whether *Congermuræna* should not be used, and *Ophisoma* be made a synonym of *Conger*. As, however, one of the typical species of *Ophisoma* is a member of this genus, and as the name has been restricted to this genus by Bleeker, it seems best to use the older name.

Ariosoma, which is still older, we do not adopt because no species is mentioned in connection with it, and the definition is wholly inadequate for determination. Swainson distinguishes it from *Anguilla* as follows: "Spiracle before the base of the pectoral; nostrils simple." We can infer its identity with *Ophisoma* only from the fact that the latter takes the place in the systematic synopsis in the latter part of the work which *Ariosoma* has in the analytical keys. In other words, the genus which at first Swainson proposed to call *Ariosoma* he afterwards described as *Ophisoma*.

The species of this genus are very closely related. *Conger punctus* Jenyns doubtfully referred to this genus by Günther, is, as elsewhere stated, not an eel at all, but a Lycodid (*Maynea puncta*). We are indebted to Dr. Gilbert for a revision of our account of this genus.

ANALYSIS OF EUROPEAN AND AMERICAN SPECIES OF OPHISOMA.

a. Vent submedian; the body and tail about equal in length; upper jaw but little projecting; lips thin; head about 6 in total length; the tail a little longer than the head and trunk; eye about equal to snout, 5 in head. Color brownish or yellowish; silvery on sides and below; vertical fins with a narrow black edge ....BALEARICUM, 114.

aa. Vent anterior in position, the tail much longer than the body.

b. [Snout comparatively short and heavy, blunt, and broadly rounded, projecting but little beyond tip of mandible; tail twice length of body; lips full; teeth in mandible in a broad band, those of outer series the largest; maxillary and vomerine teeth also in broad bands; vomerine patch divided by a groove into which fits the tip of the mandible; no teeth on shaft of vomer; posterior nostril an elliptical slit, on level of upper margin of pupil; anterior nostril a round pore near tip of snout; five large mucous pores on each side of jaws; gape extending slightly beyond pupil, 2¾ in head; eye moderate, ¾ in snout, 6 in head; head 1⅕ in trunk, 4 in tail; pectorals ½ length of head; origin of dorsal slightly behind base of pectorals. Color dusky above; under side of head and abdomen light, the two areas separated by a well-defined line; fins dusky, becoming black towards tip of tail, with whitish border; inside of mouth, gill cavity, and peritoneum silvery.] (*Gilbert*)..................................MACRURUM, 115.

bb. Snout long and acute, projecting well beyond tip of mandible.

c. Tail less than twice length of body.

**d.* Eye large, equaling snout, 5 in head. [Upper lip much swollen and thickened; upper jaw pointed, much projecting beyond lower; tail considerably longer than the body; dorsal beginning immediately behind the gill-opening. Coloration uniform.] (*Günther.*)....................................MYSTAX, 116.

dd. [Eye small, 2 in snout, 8½ in head, slightly less than length of gill-slit; snout long and sharp, the acute tip projecting beyond mandible for ⅔ length of orbit; teeth villiform, in broad bands, none of them enlarged, a transverse groove behind head of vomer to receive tip of mandible; posterior nostril slit-like, the anterior with distinct membranous tube; mandibles very broad and strong; gape reaching to vertical from posterior margin of pupil, ⅓ of head; conspicuous pore just behind angle of mouth; head

* Taken from Steindachner's description, which reads: "The point of the upper jaw projects considerably beyond the lower jaw; the angle of the mouth lies in a vertical direction from the middle of the eye; the eyes of unusual size, their diameter equaling the snout or contained 5 times in the head," etc.

equal to trunk, 3 in tail without fin; depth 13 in total length; pectoral $3\frac{1}{2}$ in head; dorsal beginning in advance of gill-opening, its distance from tip of snout slightly less than half the distance from snout to anal. Uniform light brown; fins dusky, black near tip of tail, and there with narrow bright white margin; mouth, gill-cavity and peritoneum black.] (*Gilbert*) PRORIGERUM, 117.

cc. Tail much more than twice length of body; body slender; tail compressed; lower jaw considerably shorter than the upper; dorsal beginning slightly in advance of the root of the pectoral. Head $1\frac{1}{7}$ in trunk, $5\frac{1}{3}$ in tail; tail $2\frac{2}{3}$ times as long as head and trunk; snout $4\frac{1}{4}$ in head, very soft; eye very large, 7 in head, $1\frac{2}{3}$ in snout; interorbital area 2 in eye; cleft of mouth $3\frac{1}{5}$ in head, extending slightly behind middle of eye; pectoral long and narrow, $2\frac{4}{5}$ in head, $1\frac{3}{4}$ times as long as gill-slit. Color olivaceous, upper parts of head and body with numerous fine black dots; a silvery shade across opercles and below lateral line; peritoneum bright silvery, giving belly a pale color; dorsal and anal with a narrow black margin, below which are a few small spots; pectoral pale .... NITENS, 118.

114. OPHISOMA BALEARICUM.

Murœna balearica De La Roche, Ann. Mus., 327, fig. 3, 1809 (*fide* Günther).
Conger balearicus Costa, Faun. Nap. Pesc., tab. 29, 1845 (*fide* Günther).
Conger-Murœna balearica Kaup, Apodes, 110, 1856.
Congromurœna balearica Günther, VIII, 41, 1870 (Malta; Algiers).
Ophisoma balearicum Gilbert, Proc. U. S. Nat. Mus., 1891 (Galapagos Islands).
Echelus ciuciara Rafinesque, Caratteri, 65, 1810 (Sicily).
Murœna cassini Risso, Ich. Nice, 91, 1810 (Nice).
Ophisoma acuta Swainson, Fish. Rept. Amph., II, 396, 1839 (Sicily).
Conger opisthophthalmus Ranzani, De Nov. Spec. Pisc. Disser., Prima 16, tab. V, fig. 1, 1838 (Bahia).
Conger microstomus Castelnau, Anim. Nouv. Rares, Amérique du Sud, 83, pl. 42, fig. 4, 1855 (Rio Janeiro).
Conger analis Poey, Memorias, II, 318, 1860 (Havana).
Ophisoma analis Poey, Repertorio, II, 248, tab. 3, fig. 3, 1866 (Havana).
Congromurœna analis Poey, Enumeratio, 152, 1875 (Havana).
Conger impressus Poey, Mem. Cub., II, 318, 1860 (Cuba).
Ophisoma impressus Poey, Repertorio, II, 248, 1866.
Congromurœna impressa Poey, Enumeratio, 152, 1875.
Congromurœna mellissii Günther, VIII, 42, 1870 (St. Helena).
Leptocephalus conger Jordan & Gilbert, Proc. U. S. Nat. Mus., 378, 1883 (Cape St. Lucas).

Habitat: Mediterranean Sea and both Atlantic and Pacific shores of tropical America.

Etymology: From the Balearic Islands.

This species is not rare in the Mediterranean Sea, and apparently extends to both the Atlantic and Pacific shores of tropical America. As it now stands the range of the species is wide, and there may prove, upon comparison of specimens from different parts of the range, to be specific differences; as yet no such comparison has been made. The specimens before us are from Palermo, and from the Bonaparte collection without locality. We have compared these with Poey's account of the Cuban species called *impressus*, and can find no difference. *Conger analis* Poey, also from Cuba, seems to differ only in the slightly larger

mouth and stronger teeth, and is probably identical with *impressus*. *Congromuræna mellissii* Günther seems to belong here rather than under the synonymy of *mystax*, where it is placed by Dr. Steindachner. *Conger opisthophthalmus* and *Conger microstomus* seem to be the same, and specimens recently obtained by Dr. Gilbert from the Galapagos Islands seem referable to this species. Should the American species prove different, it will stand as *Ophisoma opisthophthalmus*

115. OPHISOMA MACRURUM.

Ophisoma macrurum Gilbert, MSS. (Gulf of California).

Habitat: Gulf of California.

Etymology: *Μακρός*, long; *οὐρά*, tail.

One specimen, 9½ inches long, was obtained by Dr. Gilbert in the Gulf of California.

116. OPHISOMA MYSTAX.

Muræna mystax De La Roche, Ann. Mus., 328, fig. 10, 1809 (Barcelona) (*fide* Günther).
Conger mystax Risso, Eur. Mér., III, 203, 1826.
Congermuræna mystax Kaup, Apodes, 110, 1856 (copied).
Congromuræna mystax Günther, VIII, 43, 1870; Steindachner, Ich. Beitrage, XII, 2, 1882 (Spalato).
Echelus nebulosus Rafinesque, Caratteri, 64, 1810 (Sicily).

Habitat: Mediterranean Sea and eastern Atlantic.

Etymology: *Μύσταξ*, upper lip; the original type having a thick and swollen upper lip.

This species is known to us only from descriptions. According to Steindachner, *Congromuræna mellissii* is identical with *Conger mystax* of De La Roche. The differences between *mystax* and *balearicum*, however, seem to lie in the swollen lips, the greatly projecting upper jaw, and the longer tail of the former, and in these respects *mellissii* wholly agrees with *balearicum*.

117. OPHISOMA PRORIGERUM.

Ophisoma prorigerum Gilbert, MSS. (Panama; Ecuador). [Two specimens: one 10¼ inches long from off the coast of Ecuador; the other from the Bay of Panama.] (Gilbert.)

Habitat: Pacific coast of tropical America.

Etymology: *Prora*, prow; *gero*, I bear.

118. OPHISOMA NITENS.

Ophisoma nitens Jordan & Bollman, Proc. U. S. Nat. Mus., 153, 1890 (off Bay of Panama, 8° 47′ N., 79° 29′ 30″ W., in 14 fathoms).

Habitat: Pacific coast of tropical America.

Etymology: Latin, *nitens*, shining.

This species is known from one specimen dredged by the *Albatross* at station 2801, off Panama.

Genus 43.—LEPTOCEPHALUS.

(*a*) Adult Forms.

Echelus Rafinesque, Caratteri, etc., 63, 1810 (includes species of *Conger*, *Ophisoma*, and *Myrus*; restricted by Bleeker to *Myrus*).

Echelus Jordan, Manual Vert., ed. v, 90, 1888 (*conger*) (not *Echelus* Rafinesque as restricted by Bleeker).

Conger Cuvier, Règne Animal, ed. II, 1827 (*conger*).

Congrus Richardson, Voyage Erebus and Terror, 1844, 107 (*conger*).

Conger Bleeker, Günther, etc. (*conger*).

(*b*) Larval Forms.

Leptocephalus Gmelin, Syst. Nat., 1150, 1788 (*Morrissi:* a larval form, probably of *Conger conger*); Risso, Europe Méridionale, 201, 1826.

Oxyurus Rafinesque, Caratteri, 19, 1810 (*vermiformis*, a larva).

Helmictis Rafinesque, Indice d'Ittiologia Siciliana, 62, 1810 (*punctatus*) a larva.

Helmichthys Costa, Fauna Napoli, Pesci (*diaphanus*).

?? **Leptocephalichthys** Bleeker, Act. Soc. Sci. Ind. Veerl., 1, Manado., 69 (*hypselosoma*).

?? **Diaphanichthys** Peters, Monatsber. Ak. Wiss. Berl., 399, 1864 (*brevicaudus*).

Type: *Muræna conger* L.

Etymology: λεπτός, slender; κεφαλή, head.

This genus contains the well known and widely distributed Conger eel and three or four closely related species. The earliest generic name used for members of the group is that of *Leptocephalus*, based on a curious, elongate, transparent, band-like creature with minute head and very small mouth, found in the waters of Europe, and known as *Leptocephalus morrissi*. This has been shown by Gill and Günther to be the young and larval form of *Conger conger*. A number of genera and species of the supposed family of *Leptocephalidæ* have been described, but there is no doubt that all of them are larvæ, some of eels as *Conger* and *Nettastoma*, others of Isospondylous fishes, as *Albula*, *Elops*, *Alepocephalus*, *Stomias*, *Fierasfer*. Whether these forms are normal young or individuals abnormally arrested in development is not certain. Dr. Günther inclines to the latter opinion, but the observations of Dr. Gilbert on the leptocephalous forms of *Albula*, *Elops*, and *Conger* seem to point to the former conclusion. For a full discussion of these larval forms see Günther, VIII, 136.

Although as the name *Leptocephalus* has been associated for more than a century with these larval forms it is a decided inconvenience to accord to it precedence as a generic name over *Conger*. The strict law of priority, however, demands its retention, and the tendency among systematic zoölogists is to recognize as few exceptions as may be to this rule.

The fish described by Jenyns from Tierra del Fuego under the name of *Conger punctus* (Voyage of the *Beagle*, Fishes, 143, 1842), and doubtfully referred by Günther to *Congromuræna* (*Ophisoma*) is not an eel at all, but belongs to the *Lycodidæ* and is apparently identical with *Maynea patagonica* (Cunningham). It may stand as *Maynea puncta*.

ANALYSIS OF THE AMERICAN SPECIES OF LEPTOCEPHALUS.

a. [Dorsal beginning the length of pectoral behind the extremity of that fin. Uniform brown; vertical fins with black edge.] (*Günther*)......MULTIDENS, 119.

aa. Dorsal beginning opposite to or just behind the tip of the pectoral; eye 1½ in snout, 5 to 6 in head; snout 3¼ to 4¼ in head; gape extending nearly or quite to posterior margin of eye; head 1⅔ to 1$\frac{6}{7}$ in trunk; tail longer than rest of body; pectorals 3½ in head; upper lip full, with conspicuous pores. Ashy gray or blackish; vertical fins with a black margin; body sometimes (var. *niger*) entirely black.................................CONGER, 120.

aaa. Dorsal fin beginning above the middle of pectorals; eye as long as snout, 4½ in head; gape extending to beyond the middle of the eye; head 1⅓ to 1¾ in trunk; tail longer than rest of body; pectorals 3 to 3½ in head. Brown, vertical fins with a broad black margin, which is again edged with white; the dorsal black anteriorly for ⅔ its depth.............................CAUDILIMBATUS, 121.

119. LEPTOCEPHALUS MULTIDENS.

Conger multidens Castelnau, Anim. Amer. Sud, 84, pl. 44, fig. 1, 1855 (Rio Janeiro); Kaup, Apodes, 114, 1856 (copied); Günther, VIII, 40, 1870 (copied).

Conger brasiliensis Kaup, Apodes, 115, 1856 (Brazil) (not of Ranzani).

Habitat: Coast of Brazil.

Etymology: Latin, *multus*, many; *dens*, tooth.

This species is known to us only through descriptions.

120. LEPTOCEPHALUS CONGER.

(THE COMMON CONGER; CONGER EEL.)

(*a*) ADULT FORMS.

Muræna supremo margine pinnæ dorsalis nigro Artedi, Synon., 40, 2, 1738 (Mediterranean).

Muræna conger Linnæus, Syst. Nat., ed. X., 245 (based on Artedi, and of the early copyists).

Conger conger Jordan, Proc. U. S. Nat. Mus., 370, 1885 (Havana).

Muræna nigra Risso, Ich. Nice, 93, 1810, (Nice).

Conger niger Risso, Eur. Mér., 201, 1826 (black variety) (Nice).

Conger vulgaris Cuvier, Règne Animal, ed. II, 1827; Günther, VIII, 38, 1870, and of European writers generally.

Anguilla oceanica Mitchill, Jour. Acad. Nat. Sci. Phila., 407, 1818.

Conger verus Risso, Eur. Mér., III, 201, 1826 (Nice).

Ophisoma obtusa Swainson, Fish., Rep., and Amph., II, 395, 1839 (Sicily).

Conger orbignyanus Valenciennes, D'Orbigny, Voy. Am. Mérid., Poiss., pl. 12, 1 (South America); Kaup, Apodes, 115, 1856 (copied).

Conger rubescens Ranzani, De Novis Spec. Pisc. Diss. Prima, 1838, 19, tab. v, fig. 5 (Mediterranean Sea).

Conger occidentalis DeKay, Fishes, N. Y., 314, pl. 53, fig. 172, 1842 (New York).

Congrus leucophæus Richardson, Voy. Ereb. and Terror, Fish., 108, 1844 (*fide* Günther.)

Conger verreauxi Kaup, Apodes, 115, 1856 (no habitat).

Conger oceanicus Gill, Cat. Fishes E. C. N. A., 1871, and of several American authors.

Conger esculentus Poey, Memorias, II, 346, 1860 (Cuba).

(*b*) LARVAL FORMS (*Leptocephalus*).

The following list includes most of the larval Congers and other eels described under the name of *Leptocephalus*. Probably none are valid species, but only a few have been positively identified:

Leptocephalus morrissi Gmelin, Syst. Nat., 1150, 1788 (Holyhead, England); Günther, VIII, 139, 1870 (a true Conger).

Ophidium pellucidum Couch, Lond. Mag. Nat. Hist., v, 313, 742 (England) (Conger).

Lepidopus pellucidus Risso, Ichthy. Nice, 152, pl. 5, fig. 19, 1810 (Nice).
Leptocephalus spallanzani Risso, Eur. Mérid., III, 205, 1826 (Mediterranean).
Leptocephalus gussoni Cocco, Isis., 1340, 1831 (Mediterranean).
Leptocephalus candidissimus Costa, Faun. Nap. Pesci, C. tab. (Naples
Leptocephalus bibronii Kaup, Apodes, 149, fig. 12, 1856.
Leptocephalus gegenbauri Kaup, Apodes, 149, fig. 11, 1856 (Messina).
Leptocephalus köllikeri Kaup, Apodes, 148, fig. 10, 1856 (Messina).
Leptocephalus longirostris Kaup, Apodes, 150, fig. 14, 1856 (Messina).
Leptocephalus punctatus Kaup, Apodes, 148, fig. 8, 1856 (Nice).
Leptocephalus brevirostris Kaup, Apodes, 150, fig. 15, 1856 (Messina).
Helmichthys diaphanus Costa, Faun. Napol. Pesc., tab. 31 (Naples).
Leptocephalus gracilis Storer, Mem. Am. Ac., II, 524 (Massachusetts).
Leptocephalus diaphanus Kaup, Apodes, 148, fig. 9, 1856 (Messina).
Leptocephalus yarrelli Kaup, Apodes, 149, fig. 13, 1856 (Messina).
Leptocephalus haeckeli Kaup, "Ann. and Mag. Nat. Hist., VI, 270, pl. 3, fig. B, 1860" (Messina).
Leptocephalus multimaculatus Steindachner, Ich. Notiz, IX, 27, 1869 (Peru).
Leptocephalus peruanus Steindachner, l. c., 28 (Peru).
Leptocephalus affinis Facciolà, Atti. Soc. Tosc., 4, fig. 1, 1884 (Straits of Messina).
Leptocephalus inornatus, l. c., p. 5, fig. 2.
Leptocephalus sicanus, l. c., p. 5, fig. 3.
Leptocephalus borelli, l. c., p. 6, fig. 4.
Leptocephalus inæqualis, l. c., p. 7, fig. 5.
Leptocephalus maurolici, l. c., p. 7, fig. 6.
Leptocephalus gutturosus, l. c., p. 8, fig. 7.
Leptocephalus peloritanus, l. c., p. 9, fig. 8.
Leptocephalus zancleus, l. c., p. 9, fig. 9.
Leptocephalus tenuirostris, l. c., p. 10, fig. 10.
Leptocephalus prestandreæ, l. c., p. 10, fig. 11.
Leptocephalus esopus, l. c., p. 11, fig. 12.
Leptocephalus oxyrhynchus Bellotti, Atti. Soc. Ital., XXVI, 177, 1884 (Messina).
Leptocephalus polloni Facciolà, Atti. Soc. Mod. Mem., I, 119, fig. 1, 1889 (Sea of Messina).
Leptocephalus lalandii, l. c., 120, fig. 2.

Habitat: Atlantic Ocean on both coasts from Cape Cod to Brazil, also in the Western Pacific, but not found on the Pacific coast of North or South America.

Etymology: Latin, *Conger*, the ancient name.

The Conger eel is generally common in the warmer parts of the Atlantic and its islands. Our specimens are from Naples, Palermo, Paris, Havana, and Charleston. The young example in the National Museum from Cape San Lucas, assigned to this species by Jordan and Gilbert (Proc. U. S. Nat. Mus., 378, 1882), belongs to *Ophisoma balearicum*. Of the forms called *Leptocephalus* only three (*L. gracilis* Storer, from Massachusetts, and *L. multimaculatus* and *L. peruanus* Steindachner, from Peru) have been described from American waters.

Leptocephalus gracilis is doubtless (like *L. morrissi*) a young Conger. *L. multimaculatus* from Peru, a slender form with a sharp nose, we are unable to recognize from the description, as also the deep bodied and band-shaped *Leptocephalus peruanus*. We refer to these species for the

sake of completeness, but as larval forms of unknown species they should have no place in systematic lists.

A number of specimens before us, from Palermo, labeled by Dr. Dodderlein *Leptocephalus punctatus*, seem to be the young of the Conger.

121. LEPTOCEPHALUS CAUDILIMBATUS.

Echelus caudilimbatus Poey, Repertorio, II, 249, 1867 (Cuba). Poey, Ann. N. Y. Acad. Nat. Hist., 322, 1870.
Ophisoma caudilimbatus Poey, Synopsis, 424, 1867 (Cuba).
Conger caudilimbatus Poey, Enumeratio, 152, 1875 (Cuba).
Conger macrops Günther, 40, 1870 (Madeira; Bahama Islands).
Conger caudicula Bean, Proc. U. S. Nat. Mus., 435, 1882 (Pensacola); Jordan & Gilbert, ibid, 262 (Pensacola); Jordan & Gilbert, Syn. Fish. N. A., 900, 1883.

Habitat: Tropical Atlantic, Pensacola to Madeira.

Etymology: Latin, *cauda*, tail; *limbatus*, margined.

Of this species we have examined several examples, identical with the type of *C. caudicula*, from the Snapper Banks of Pensacola. We do not see that these differ in any important respect from the descriptions of *macrops* and *caudilimbatus* and refer all to one species.

Family IX.—ANGUILLIDÆ.

(THE TRUE EELS.)

The true eels or *Anguillidæ* are characterized by their scaly skin in connection with a conical head and a general resemblance to the *Congridæ*. The group is thus diagnosed by Dr. Gill:

> Enchelycephalous Apodals with conical head, well-developed opercular apparatus, lateral maxillines, cardiform teeth, distinct tongue, vertical lateral branchial apertures, continuous vertical fins with the dorsal far from the head, pectorals well developed, scaly skin, and nearly perfect branchial skeleton.

The *Anguillidæ* approach more nearly than most of the other eels to the type of the true fishes. In one respect, that of the minute ova and concealed generation, however, they differ widely from these. The single genus of living *Anguillidæ* is widely diffused in temperate and tropical waters. Unlike the other eels the *Anguillidæ* freely ascend the rivers, descending to the sea for purposes of reproduction.

ANALYSIS OF GENERA OF ANGUILLIDÆ.

a. Dorsal fin inserted well behind base of pectorals; shoulder girdle well developed; lower jaw projecting...ANGUILLA, 44.

Genus 44.—ANGUILLA.

Anguilla "Thunberg, Nouv. Mem., Stockholm, about 1795" (reference unverified).
Anguilla Shaw, General Zoölogy, IV, 15, 1804 (*Anguilla*).
Terpolepis "McClelland," (*fide* Day).

Muræna Bleeker, Poey, etc. (taking as type *Muræna anguilla*, the first species mentioned by Artedi under *Muræna*).
Anguilla Kaup, Günther, Gill, and of authors generally.

Type: *Muræna anguilla* L.

Etymology: *Anguilla* (*Ἔγχελυς*), the original name of the eel.

This genus is widely distributed through the waters of the North Temperate and Torrid Zone, being only absent in the Eastern Pacific. Unlike the other eels, its species freely enter fresh waters, and they are subject to great variations in form, size, and color, which have given rise to a host of nominal species.

ANALYSIS OF AMERICAN AND EUROPEAN SPECIES OF ANGUILLA.

a. Distance between origin of dorsal and vent $\frac{5}{6}$ to $1\frac{1}{4}$ in head; pectoral 3 to $3\frac{2}{3}$ in head; head $2\frac{1}{2}$ to $2\frac{4}{5}$ in trunk; upper jaw $3\frac{3}{4}$ to $4\frac{1}{4}$ in head. Yellow, brown, or black, underparts paler .... ANGUILLA, 122.
aa. Distance between origin of dorsal and vent $1\frac{1}{6}$ to 2 in head; pectoral $2\frac{5}{6}$ to $3\frac{2}{5}$ in head; head 2 to $2\frac{1}{2}$ in trunk; body more robust and trunk slightly shorter than in *anguilla*, otherwise similar .... CHRYSYPA, 123.

122. ANGUILLA ANGUILLA.

(THE COMMON EEL.)

Muræna unicolor maxilla inferiore longiore Artedi, Genera Pisc., 24, 1738.
Muræna anguilla Linnæus, Syst. Nat., ed. x, 245, 1758 (after Artedi).
Anguilla vulgaris Shaw, Gen. Zoöl., IV, 15, pl. 1, 1804 (after Linnæus).
Anguilla vulgaris marina Rafinesque, Indice, 38, 1810 (Sicily).
Anguilla vulgaris fluviatilis Rafinesque, l. c. (Sicily).
Anguilla fluviatilis Heckel & Kner, Süsswasserfische, 319, 1858 (Dalmatia) (*fide* Günther).
Anguilla acutirostris Risso, Eur. Mér., III, 198, 1826 (Nice).
Anguilla vulgaris acutirostris Doderlein, Atti. Acc. Soc., 58, 1879.
Anguilla mediorostris Risso, Eur. Mér., III, 198, 1826.
Anguilla vulgaris mediorostris Reguis, Bull. Soc. d'Études, 126, 1881 (Provence).
Muræna eurhina Ekström, Fisch. Mörkö, 142, 1835 (*fide* Günther).
Muræna platyrhina Ekström, Fisch. Mörkö, 142, 1835 (*fide* Günther).
Anguilla canariensis Valenciennes, in Webb & Berthelot, Îles Canar., Poiss., 88, pl. 20, fig. 1, 1838.
Anguilla platyrhynchus Costa, Fauna Napoli, Pesc., tab. 58 and 60, fig. 3, 1840 (*fide* Günther).
Anguilla septembrina Bonaparte, Cat. Pesc. Eur., 38, 1846 (Central Italy).
Anguilla cloacina Bonaparte, l. c. (southern Europe).
Anguilla callensis Guichenot, Explor. Alger., Poiss., III, pl. 7, fig. 1. 1850 (Calle, Algiers.)
Anguilla migratoria Kröyer, Danmark's Fiske, III, 616, 1853 (*fide* Günther).
Anguilla kieneri Kaup, Apodes, 32, fig. 15, 1856.
Anguilla vulgaris kieneri Reguis, Bull. Soc. d'Études, 126, 1881 (Provence).
Anguilla cuvieri Kaup, Apodes, 33, 1856.
Anguilla bibroni Kaup, Apodes, 33, fig. 16, 1856 (Sicily).
Anguilla savignyi Kaup, Apodes, 34, 1856 (Naples).
Anguilla capitone Kaup, Apodes, 34, fig. 17, 1856 (Naples).
Anguilla vulgaris capitone Doderlein, Att. Acc. Soc., 58.
Anguilla marina Kaup, Apodes, 35, fig. 18, 1856 (Naples).
Anguilla melanochir Kaup, Apodes, 35, fig. 19, 1856 (Tiber).

Anguilla marginata Kaup, Apodes, 36, fig. 20, 1856 (Valentia).
Anguilla microptera Kaup, Apodes, 36, fig. 21, 1856 (Bay of Algesirus).
Anguilla ancidda Kaup, Apodes, 37, fig. 22, 1856 (Sicily).
Anguilla altirostris Kaup, Apodes, 37, fig. 24, 1856 (Seine).
Anguilla platycephala Kaup, Apodes, 38, fig. 25, 1856 (Baillon).
Anguilla latirostris Kaup, Apodes, 38, fig. 26, 1856 (L'Orient).
Anguilla vulgaris latirostris Reguis, Bull. Soc. d'Études, 126, 1881 (Provence).
Anguilla nilotica Kaup, Apodes, 40, fig. 28, 1856 (Nile River).
Anguilla ægyptica Kaup, Apodes, 40, 1856 (Nile).
Anguilla eurystoma Heckel & Kner, Süsswasserfische, 325, 1858 (Dalmatica) (*fide* Günther).
Anguilla hibernica Couch, Brit. Fish., IV, 328, pl. 235, 1865 (*fide* Günther).
Anguilla vulgaris platirostris Doderlein, Att. Acc. Soc., 58, 1879.
Anguilla vulgaris oblongirostris Reguis, Bull. Soc. d'Études, 126, 1881 (Provence).

Habitat: Coast of Europe and Northern Africa (not found north of lat. 64° 30′, nor in the Danube River, Black and Caspian Seas), Azores, Canary, and Cape Verde Islands. Perhaps also in the East Indies.

Etymology: *Anguilla*, eel.

We have regarded all the nominal species of *Anguilla* from Europe as identical, as no reliable specific differences have yet been indicated among them. We exclude Asiatic references, as we have had no satisfactory material for comparison, and other forms may exist. The eel is excessively common in southern Europe. We have specimens from Athens, Venice, Palermo, and Paris.

123. ANGUILLA CHRYSYPA.

(THE AMERICAN EEL.)

Muræna anguilla Schöpf, Beobacht. Naturforscher, VII, 138, 1788 (New York) (*fide* Günther) (not of L).
Anguilla vulgaris Mitchill, Trans. Lit. & Phil. Soc., 360, 1814 (not of Shaw).
Anguilla chrysypa Rafinesque, Amer. Mont. Mag. & Crit. Rev., 120, 1817 (Lake George; Hudson River; Lake Champlain).
Anguilla blephura Rafinesque, l. c., 120, 1817 (Long Island).
Anguilla laticauda Rafinesque, Amer. Monthly Mag. & Crit. Rev., 445 (Ohio River).
Anguilla aterrima Rafinesque, Ichthyologia Ohiensis, 78, 1820 (Ohio River).
Anguilla xanthomelas Rafinesque, Ich. Ohiensis, 78, 1820 (Ohio River).
Anguilla lutea Rafinesque, Ich. Ohiensis, 78, 1820 (Ohio River).
Muræna rostrata Le Sueur, Jour. Acad. Nat. Sci. Phil., 1821, 81 (Cayuga Lake).
Anguilla rostrata DeKay, Fish. N. Y., 312, 1842 (Cayuga and Seneca Lakes).
Anguilla anguilla rostrata Meek, Bull. U. S. Fish. Com., 430, 1883.
Muræna bostoniensis Le Sueur, Journ. Acad. Nat. Sci. Phil., 1821, 81.
Anguilla bostoniensis DeKay, Fishes N. Y., 313, 1842 (northern coast).
Muræna serpentina Le Sueur, Journ. Acad. Nat. Sci. Phil., 82, 1821 (Newport, R. I.).
Anguilla serpentina Storer, Syn. Fish. N. A., 486, 1845.
Muræna macrocephala Le Sueur, Journ. Acad. Nat. Sci. Phil., 82, 1821 (Saratoga, N. Y.).
Anguilla macrocephala DeKay, Fishes N. Y., 313, 1842.
Anguilla tenuirostris DeKay, Fishes N. Y., 310, 1842.
Muræna argentea Le Sueur, Journ. Acad. Nat. Sci. Phil., 82, 1821 (Boston Bay).
Anguilla argentea DeKay, Fishes N. Y., 313, 1842 (northern coast).
Anguilla novæorleanensis Kaup, Apodes, 43, fig. 33, 1856 (New Orleans, La.)
Anguilla punctatissima Kaup, Apodes, 44, 1856 (Niagara).

Anguilla cubana Kaup, Apodes, 44, 1856 (Cuba).
Muræna cubana Poey, Syn., 421, 1868 (Havana).
Anguilla novæterræ Kaup, Apodes, 45, fig. 35, 1856 (Newfoundland).
Anguilla texana Kaup, Apodes, 45, fig. 36, 1856 (Texas).
Anguilla wabashensis Kaup, Apodes, 46, 1856 (Wabash River).
Anguilla tyrannus Girard, U. S. and Mex. Bound. Surv., 75, 1859 (Rio Grande).

Habitat: Atlantic coast from Maine to Mexico, and throughout the West Indies; also, ascending all rivers east of the Rocky Mountains and South of Canada.

Etymology: *Χρυσός*, gold; *ὕπο*, below.

Among the multitudes of American eels examined by us we have been unable to detect specific differences. As all these specimens differ in a slight degree from any we have seen from Europe, we may provisionally recognize the American form under its oldest name, *Anguilla chrysypa*, as a distinct species. As these differences are slight, it is not unlikely that intermediate forms may occur, in which case the American form may stand as var. *chrysypa*. Dr. Bean records in the "Nineteenth Report of the Commission of Fisheries of New York, page 280," five individuals from Great South Bay, Long Island, which he thinks may represent *Anguilla argentea* Le Sueur. These specimens are described as having "large eyes, short snout, and long pectoral fins as compared with the common form, silvery gray above with a clear satiny white abdomen separated from the color above by the lateral line." These specimens are very interesting because they were found "to be males with the generative glands so well developed as to leave no doubt concerning the sex."

Family X.—SIMENCHELYIDÆ.

This family contains a single species, a deep-sea parasitic eel, having the general characters of *Anguilla*, but with the form of the head strikingly different. The following diagnosis is given by Dr. Gill:

Apodal fishes with a blunt snout, transverse, anterior mouth, massive jaws with an acrodont dentition, and inferior longitudinal branchial slits moderately far apart from each other.

The skin has the peculiar rudimentary scales of *Anguilla*; the teeth are blunt, uniserial, on the edge of the jaws only, and there are no lips.

Genus 45.—SIMENCHELYS.

Simenchelys Gill in Goode & Bean, Bull. Essex Inst., 27, 1879 (*parasiticus*).
Conchognathus Collett, Bull. Soc. Zool. France, 122, 1889 (*grimaldii*).

Type: *Simenchelys parasiticus* Gill.

Etymology: *Σιμός*, snub-nosed; *ἔγχελυς*, eel.

This genus contains a single species from the Atlantic.

ANALYSIS OF SPECIES OF SIMENCHELYS.

a Anterior profile of head bluntly rounded; angle of mouth at a point half-way between the tip of snout and anterior edge of eye; body stout, the depth at vent about equal to length of head; dorsal beginning about a head's length behind gill-openings; eye $1\frac{1}{2}$ to 2 in snout; pectoral $2\frac{1}{2}$ in head; head $4\frac{1}{2}$ to $4\frac{3}{5}$ in trunk; tail a head's length longer than head and trunk; color brown, nearly plain. PARASITICUS, 124.

124. SIMENCHELYS PARASITICUS.

Simenchelys parasiticus Gill (MSS.) in Goode & Bean, Bull. Essex Inst., 27, 1879 (Newfoundland Banks); Bean, Proc. U. S. Nat. Mus., 113, 1880 (a list of localities); Goode, ibid, 485; Jordan & Gilbert, Syn. Fish N. A., 363, 1883; Günther, Voy. Challenger, XXII, 252, 1887.

Conchognathus grimaldii Collett, Bull. Soc. Zool. France, 122, 1889 (Azores Islands).

Habitat: Deep waters of the Atlantic.

Etymology: Latin, parasitic.

This singular eel is occasionally taken in the North Atlantic, where it burrows into the flesh of the halibut (*Hippoglossus hippoglossus*). Our specimen is from the Grand Banks of Newfoundland.

Family XI.—ILYOPHIDIDÆ.

This family contains a single species with characters intermediate between the *Simenchelyidæ* and the *Synaphobranchidæ*, combining the general physiognomy of *Synaphobranchus* with the separate gill-slits and long-bowed branchiostegal rays of *Simenchelyidæ* (*Gilbert*).

Genus 46.—ILYOPHIS.

Ilyophis Gilbert, MSS.

This genus is thus described by Dr. Gilbert:

Body scaly; pectorals well developed; lateral line prominent; gill-slits horizontal, inferior, well separated; nostrils lateral, the posterior immediately in front of the eye, the anterior with a short tube, near tip of snout. Maxillaries as in *Synaphobranchus;* the clamping processes closely appressed to the side of the vomer behind its head; lower jaw strong, apparently with the coronoid process well developed; series of teeth on head and shaft of vomer continuous; no lips; tongue little developed, with narrow free margin; branchiostegal rays 15 in number (as determined without dissection), not shortened, some of them curved around and above the opercle. Dorsal, anal, and caudal confluent, rather high, the rays clearly visible through the skin; dorsal beginning well forward, its origin immediately behind the base of pectorals; origin of anal near end of anterior third of body.

Type: *Ilyophis brunneus* Gilbert.

Etymology: Ἰλύς, ooze; ὄφις, snake.

ANALYSIS OF THE SPECIES OF ILYOPHIS.

a. [Body narrow, compressed throughout; snout and jaws slender; gape one-half length of head, extending beyond the eye for a distance less than the diameter of the latter; maxillary teeth small, bluntly conic, in narrow band; teeth on vomer large, conic, those on shaft of vomer in single row; teeth in mandible in narrow band, those on the inner series enlarged and retrorse though less than half the size of the vomerine teeth; front of pupil over end of second third of length of jaw; gill-slits narrow, inferior, horizontal, crescent-shaped, about equaling horizontal diameter of eye, their lower (anterior) ends separated by a distance equal to their own length, their upper (posterior) ends by 1½ times that distance; head 2 in trunk; head and trunk 3½ in total length; pectorals small, 6 in head, rays evident; scales very fine, arranged in groups at right angles to one another; lateral line running high anteriorly, its pores white and conspicuous. Color brown, the fins, lower side of head, and branchial regions darker.] (*Gilbert.*) BRUNNEUS, 125.

125. ILYOPHIS BRUNNEUS.

Ilyophis brunneus Gilbert, MSS. (Chatham Island).

Habitat: Galapagos Islands.

Etymology: *Brunneus*, brown.

A single specimen 15 inches long was collected by the *Albatross* near Chatham Island, Galapagos, 634 fathoms.

Family XII.—SYNAPHOBRANCHIDÆ.

This group consists of deep-sea eels, differing from the *Anguillidæ* in having the gill openings externally confluent into a single slit. The following diagnosis is given by Dr. Gill:

Enchelycephalous Apodals with conic, pointed head, moderate opercular apparatus, lateral maxillines, cardiform teeth, distinct tongue, inferior branchial apertures discharging by a common aperture, continuous vertical fins, pectorals well developed, scaly skin, and nearly perfect branchial skeleton.

The form of the branchiostegals is characteristic. They are in moderate number (about 15), attached to the sides of the compressed ceratohyal and ephiyal, slender, abbreviated, and moderately bowed, not being curved up above the operculum. Two genera are known, very similar to each other.

ANALYSIS OF GENERA OF SYNAPHOBRANCHIDÆ.

a. Dorsal fin low, beginning behind vent; vomerine teeth in a single patch; pectorals long, longer than the rather slender snout.......... SYNAPHOBRANCHUS, 47.

aa. Dorsal fin beginning close behind base of pectorals; vomerine teeth in two patches, one behind the other; pectorals short, not longer than the short snout. HISTIOBRANCHUS, 48.

Genus 47.—SYNAPHOBRANCHUS.

Synaphobranchus Johnson, Proc. Zoöl. Soc. London, 169, 1862 (*kaupi*).

Type: *Synaphobranchus kaupi* Johnson = *Muræna pinnata* Gronow.

Etymology: *Συνἁφής*, united; *βράγχια*, gills.

This genus contains two or three species of deep-sea fishes from the Atlantic and Pacific.

ANALYSIS OF THE SPECIES OF SYNAPHOBRANCHUS.

a. Dorsal fin beginning ¼ to ½ head's length behind vent; maxillary reaching a poi almost opposite gill-opening; head 3 to 3½ in distance from tip of snout to dors ¼ to ⅗ in trunk; snout 3½ in head; eye 2 to 2¼ in snout; cleft of mouth 1½ to in head; pectorals 3 in head, their insertion about equidistant from snout a anus. Uniform brown, vertical fins darker behind, light-edged anteriorly; insi of mouth blue-black; gill-openings dark.......................PINNATUS, 12

126. SYNAPHOBRANCHUS PINNATUS.

Muræna pinnata Gronow, Cat. Fish. Brit. Mus., 19, 1854 (habitat unknown).
Synaphobranchus pinnatus Günther, VIII, 23, 1870 (Madeira); Goode and Bean, Bul Essex Inst., 26, 1879 (Offshore Banks, 200 to 300 fathoms); Bean, Proc. U. Nat. Mus., 113, 1880 (list of localities); Goode, ibid., 485; Goode & Bea Bull. Mus. Comp. Zoöl., 222, 1883; Jordan and Gilbert, Syn. Fish. N. A., 36 1883; Günther, Voy. Challenger, XXII, 253, 1887 (Maderia; Brazil; Japa Phillipine Islands, etc.); Vaillant, Expéd. Travailleur and Talisman, 8 1888 (Morocco; Canaries; Soudan; Cape Verde Islands; Azores; Arguina
Synaphobranchus kaupii Johnson, Proc. Zoöl. Soc. Lond., 169, 1862 (Madeira) (*fide* Gün ther).
Synaphobranchus affinis Günther, Ann. and Mag. Nat. Hist., 445, 1877 (Inosima, Japan

Habitat: Deep waters of the north Atlantic and Pacific.

Etymology: Latin, pinnate.

The species is not rare in the deep waters of the north Atlantic, es pecially off the Newfoundland Banks. The form found in the nort Pacific, *Synaphobranchus affinis*, is now regarded by Dr. Günther a identical with the Atlantic species.

Our specimens of *Synaphobranchus pinnatus* are from the Gran Banks of Newfoundland.

Genus 48.—HISTIOBRANCHUS.

Histiobranchus Gill, Proc. U. S. Nat, Mus., 255, 1883 (*infernalis*).

Type: *Histiobranchus infernalis* Gill.

Etymology: Ἱστιον, sail, *i. e.*, dorsal fin; βράγχια, gills, from the inser tion of the dorsal.

This genus is close to the preceding, from which it is distinguishe by the insertion of its dorsal. Two species have been described, pe haps identical with each other.

ANALYSIS OF THE SPECIES OF HISTIOBRANCHUS.

a. [Pectoral fin longer than snout; eye ⅓ or ⅔ of the length of snout; head and trun 1¼ in tail; dorsal commencing above or immediately behind the pectoral, whic is only ⅓ the length of head; scales quite rudimentary, lanceolate, imbedded i the skin; cheeks naked; dorsal and anal fins low, especially the former; un formly black.] (*Günther*).......................BATHYBIUS, 127

aa. [Pectorals considerably shorter than snout; dorsal commencing a little behin root of pectoral, $\frac{15}{100}$ of length, while the anal arises not much nearer the snou than the end of tail; color black.] (*Gill*).......................INFERNALIS, 128

127. HISTIOBRANCHUS BATHYBIUS.

Synaphobranchus bathybius Günther, Ann. and Mag. Nat. Hist., XX, 445, 1877; ibid, Voy. Challenger, 254, pl. LXII, fig. *b*, 1887 (middle of North Pacific, South of Yedo; midway between Cape of Good Hope and Kerguelen Island).

Etymology: *βαθύς*, deep; *βίος*, life.

A specimen of this species was obtained by the *Albatross* in the depths of Bering Straits.

128. HISTIOBRANCHUS INFERNALIS.

? *Synaphobranchus bathybius* Günther, Ann. Mag. Nat. Hist., 1877, 445; Günther, Challenger, XXII, 254, pl. 62 (off Yedo; North Pacific; between Cape of Good Hope and Kerguelen Land).

Histiobranchus infernalis Gill, Proc. U. S. Nat. Mus., 255, 1883.

Habitat: Atlantic Ocean, latitude 38° 30′ 30″, longitude 69° 08′ 25″.

Etymology: Latin, infernal, from its color.

This species from the Atlantic agrees, so far as the scanty description goes, with *Synaphobranchus bathybius* Günther (Ann. Mag. Nat. Hist., 1877, 445), a species now known from various localities in the North Pacific and from the Antarctic Ocean south of the Cape of Good Hope. The only apparent difference is that the Atlantic form (*infernalis*) has the pectoral fins shorter than the other, perhaps an individual variation.

RECAPITULATION OF GENERA AND SPECIES OF EELS INCLUDED IN THIS PAPER.

The general distribution of each species is indicated by the following letters:

A, Alaskan fauna.
B, Californian fauna.
E, European fauna (north of Spain).
I, Islands of East Atlantic (Madeira, Cape Verde).
M, Mediterranean Sea.
N, East coast of United States; Cape Cod to Cape Hatteras.
P, Panama fauna.
R, Brazilian fauna.
S, South Atlantic and Gulf Coast fauna.
T, Patagonian fauna (Terra del Fuego).
V, Chilian fauna (Valparaiso).
W, West Indian fauna.

The species not studied by us are indicated by a star (*).

Order APODES.

Suborder COLOCEPHALI.

Family I. MURÆNIDÆ.

Genus 1. **Uropterygius** Rüppell.

1. *Uropterygius necturus* (Jordan & Gilbert). P.

Genus 2. **Channomuræna** Richardson.

2. *Channomuræna vittata* Richardson. W.

Genus 3. **Enchelycore** Kaup (perhaps to be called *Enchelynassa*).

3. *Enchelycore nigricans* (Bonnaterre). W.

Genus 4. **Pythonichthys** Poey.

4. *Pythonichthys sanguineus** (Poey). W.

Order **APODES**—Continued.

Suborder **COLOCEPHALI**—Continued.

Family I. MURÆNIDÆ—Continued.

Genus 5. **Gymnothorax** Bloch.

§. *Rabula* Jordan & Davis.

5. *Gymnothorax aquæ-dulcis* (Cope). P.
6. *Gymnothorax marmoreus** (Kaup) (doubtful species). I.
7. *Gymnothorax panamensis* (Steindachner). P.
8. *Gymnothorax longicauda* (Peters). W.
9. *Gymnothorax porphyreus** (Guichenot). V.

§. *Gymnothorax.*

10. *Gymnothorax unicolor* (De la Roche). M, I.
11. *Gymnothorax verrilli* (Jordan & Gilbert). P.
12. *Gymnothorax vicinus* (Castelnau). W.
13. *Gymnothorax virescens** (Poey). W.
14. *Gymnothorax polygonius* (Poey). W.
15. *Gymnothorax moringa* (Cuvier). W, E.
16. *Gymnothorax wieneri** (Sauvage) (doubtful species). V.
17. *Gymnothorax anatinus** (Lowe). I.
18. *Gymnothorax sanctæ-helenæ** (Günther). I.
19. *Gymnothorax mordax* (Ayres). C.
20. *Gymnothorax funebris* (Ranzani). W, E, P.
21. *Gymnothorax chilensis** (Günther.) V.
22. *Gymnothorax dovii* (Günther). P.
23. *Gymnothorax conspersus** (Poey). W.
24. *Gymnothorax miliaris** (Kaup). I.
25. *Gymnothorax flavopictus** (Kaup). W.
26. *Gymnothorax elaboratus* (Poey). W.
27. *Gymnothorax obscuratus** (Poey). W.
28. *Gymnothorax irregularis** (Kaup). I.
29. *Gymnothorax chlevastes* (Jordan & Gilbert). P.
30. *Gymnothorax modestus** (Kaup). V.

§. *Priodonophis* Kaup.

31. *Gymnothorax madeirensis** (Johnson). I.
32. *Gymnothorax ocellatus* (Agassiz). W.

Genus 6. **Muræna** (Artedi) Linnæus.

33. *Muræna helena L.* L, M, I.
34. *Muræna insularum* (Jordan & Davis). P.
35. *Muræna argus** (Steindachner). P.
36. *Muræna retifera* Goode & Bean. W, E.
37. *Muræna lentiginosa* (Jenyns). P.
38. *Muræna melanotis* (Kaup). W.
39. *Muræna augusti** (Günther). I.

Genus 7. **Echidna** Forster.

40. *Echidna nocturna* (Cope). P.
41. *Echidna catenata* (Bloch). W.

Suborder **ENCHELYCEPHALI.**

Family II. OPHISURIDÆ.

Genus 8. **Sphagebranchus** Bloch.

42. *Sphagebranchus cæcus** (De la Roche). M.
43. *Sphagebranchus anguiformis** (Peters) (doubtful species). W.
44. *Sphagebranchus selachops* (Jordan & Gilbert). P.
45. *Sphagebranchus acutirostris** (Barneville) (doubtful species). W
46. *Sphagebranchus rostratus** (Bloch). W.
47. *Sphagebranchus kendalli* (Gilbert). W.

Order **APODES**—Continued.

Suborder **ENCHELYCEPHALI**—Continued.

Family II. OPHISURIDÆ—Continued.

Genus 9. **Letharchus** Goode & Bean.

48. *Letharchus velifer* Goode & Bean. W, F.

Genus 10. **Myrichthys** Girard.

49. *Myrichthys pardalis** (Valenciennes). W, T.
50. *Myrichthys tigrinus* Girard. P.
51. *Myrichthys oculatus* (Kaup). W.
52. *Myrichthys acuminatus* (Gronow). W, F.

Genus 11. **Callechelys** Kaup.

53. *Callechelys murœna* Jordan & Evermann. W, F.

Genus 12. **Bascanichthys** Jordan & Davis.

54. *Bascanichthys scuticaris* (Goode & Bean). W, F.
55. *Bascanichthys bascanium* (Jordan). W, F.

Genus 13. **Cæcula** Vahl.

56. *Cæcula imberbis* (De la Roche). M.

Genus 14. **Quassiremus** Jordan & Davis.

57. *Quassiremus nothochir* (Gilbert). P.
58. *Quassiremus evionthas* (Jordan & Bollman). P.

Genus 15. **Ophichthus** Ahl.

§ *Cogrus* Rafinesque.

59. *Ophichthus hispanus* Belotti (perhaps to receive some older náme). M.
60. *Ophichthus brasiliensis** Kaup. W.
61. *Ophichthus maculatus** (Rafinesque). M.

§ *Cryptopterus* Kaup.

62. *Ophichthus ater** (Peters). V.
63. *Ophichthus puncticeps** Kaup. W.

§ *Ophichthus.*

64. *Ophichthus havannensis* (Bloch). W.
65. *Ophichthus retropinnis* Eigenmann. W, F.

§ *Murœnopsis* Kaup.

66. *Ophichthus guttifer* Bean & Dresel. W, F.
67. *Ophichthus ocellatus* (Le Sueur). W, F.
68. *Ophichthus uniserialis** (Cope). V.
69. *Ophichthus triserialis* (Kaup). P.
70. *Ophichthus grandimaculatus** Kner & Steindachner. V.
71. *Ophichthus pacifici** Günther. V.

§ *Scytalophis* Kaup.

72. *Ophichthus gomesi* (Castelnau) (perhaps includes two species, *gomesi* and *macrurus*). W, F.
73. *Ophichthus zophochir* Jordan & Gilbert. P.
74. *Ophichthus magnioculis* (Kaup). W.
75. *Ophichthus callaënsis* Günther. V.
76. *Ophichthus parilis** (Richardson) (perhaps includes two species, *parilis* and *pauciporus*). W, B.

Genus 16. **Mystriophis** Kaup.

§ *Crotalopsis* Kaup.

77. *Mystriophis intertinctus* (Richardson) (perhaps includes two or three species, *intertinctus*, *punctifer*, *schneideri*). W, F.

§ *Scytalichthys* Jordan & Davis.

78. *Mystriophis miurus* (Jordan & Gilbert). P.

Genus 17. **Brachysomophis** Kaup.

79. *Brachysomophis crocodilinus** (Bennett). P.

Order **APODES**—Continued.

Suborder **ENCHELYCEPHALI**—Continued.

Family II. OPHISURIDÆ—Continued.

Genus 18. **Ophisurus** (Lacépède) Risso.

80. *Ophisurus serpens* (L). M, I.

Family III. ECHELIDÆ.

Genus 19. **Chilorhinus** Lütken.

81. *Chilorhinus suensoni** Lütken. W.

Genus 20. **Ahlia** Jordan & Davis.

82. *Ahlia egmontis* (Jordan). W, F.

Genus 21. **Myrophis** Lütken.

83. *Myrophis frio* Jordan & Davis. B.

84. *Myrophis punctatus* Lütken. W, F.

85. *Myrophis vafer* Jordan & Gilbert. P.

Genus 22. **Paramyrus** Günther.

86. *Paramyrus cylindroideus** (Ranzani). B.

Genus 23. **Echelus** Rafinesque.

87. *Echelus pachyrhynchus** (Vaillant). M, I.

88. *Echelus myrus* (L). M.

Family IV. MURÆNESOCIDÆ.

Genus 24. **Gordiichthys** Jordan & Davis.

89. *Gordiichthys irretitus* Jordan & Davis. S.

Genus 25. **Stilbiscus** Jordan & Bollman.

90. *Stilbiscus edwardsi* Jordan & Bollman. W.

Genus 26. **Leptoconger** Poey.

91. *Leptoconger perlongus** Poey. W.

Genus 27. **Neoconger** Girard.

92. *Neoconger mucronatus** Girard. W, F.

93. *Neoconger vermiformis* Gilbert. P.

Genus 28. **Hoplunnis** Kaup.

94. *Hoplunnis schmidti** Kaup. W.

Genus 29. **Muræenesox** McClelland.

§ *Muræenesox.*

95. *Muræenesox coniceps* Jordan & Gilbert. P.

96. *Muræenesox savanna* Cuvier. W, B.

Genus 30. **Xenomystax** Gilbert.

97. *Xenomystax atrarius* Gilbert. P.

Family V. NETTASTOMIDÆ.

Genus 31. **Chlopsis** Rafinesque.

98. *Chlopsis bicolor** Rafinesque.

99. *Chlopsis equatorialis* Gilbert. P.

Genus 32. **Nettastoma** Rafinesque.

100. *Nettastoma melanurum* Rafinesque. M, A.

Genus 33. **Venefica** Jordan & Davis.

101. *Venefica procera* (Goode & Bean). A.

102. *Venefica proboscidea** Vaillant. A.

Family VI. NEMICHTHYIDÆ.

Genus 34. **Serrivomer** Gill & Ryder.

103. *Serrivomer beani* Gill & Ryder. A.

Genus 35. **Spinivomer** Gill & Ryder.

104. *Spinivomer goodei** Gill & Ryder. A.

Genus 36. **Cyema** Günther.

105. *Cyema atrum* Günther. A.

Genus 37. **Avocettina** Jordan & Davis.

106. *Avocettina infans* Günther. A, P.

107. *Avocettina richardi** Vaillant. A.

Order **APODES**—Continued.

Suborder **ENCHELYCEPHALI**—Continued.

Family VI. NEMICHTHYIDÆ—Continued.

Genus 38. **Labichthys** Gill & Ryder.

108. *Labichthys carinatus** Gill & Ryder. A.
109. *Labichthys elongatus** Gill & Ryder. A.

Genus 39. **Nemichthys** Richardson.

110. *Nemichthys scolopaceus* Richardson. A.
111. *Nemichthys avocetta* Jordan & Gilbert (perhaps identical with *N. scolopaceus*). P.

Family VII. HETEROCONGRIDÆ.

Genus 40. **Heteroconger** Bleeker.

112. *Heteroconger longissimus** Günther. A.

Family VIII. CONGRIDÆ.

Genus 41. **Uroconger** Kaup.

113. *Uroconger vicinus** Vaillant. A.

Genus 42. **Ophisoma** Swainson.

114. *Ophisoma balearicum* De la Roche. M, W, B.
115. *Ophisoma macrurum* Gilbert. P.
116. *Ophisoma mystax** De la Roche. M.
117. *Ophisoma prorigerum* Gilbert. W, B.
118. *Ophisoma nitens* Jordan & Bollman. P.

Genus 43. **Leptocephalus** Gmelin (perhaps to be called *Conger*).

119. *Leptocephalus multidens** Castelnau. B.
120. *Leptocephalus conger* (L.). E, M, N, S, F, W, B, P.
121. *Leptocephalus caudilimbatus* Poey. W, F.

Family IX. ANGUILLIDÆ.

Genus 44. **Anguilla** Shaw.

122. *Anguilla anguilla* (L.), Europe, etc.
123. *Anguilla chrysypa* Rafinesque, Eastern America (probably a variety of the preceding).

Family X. SIMENCHELYIDÆ.

Genus 45. **Simenchelys** Gill.

124. *Simenchelys parasiticus* Gill. A.

Family XI. ILYOPHIDIDÆ Gilbert.

Genus 46. **Ilyophis** Gilbert.

125. *Ilyophis brunneus* Gilbert. P.

Family XII. SYNAPHOBRANCHIDÆ.

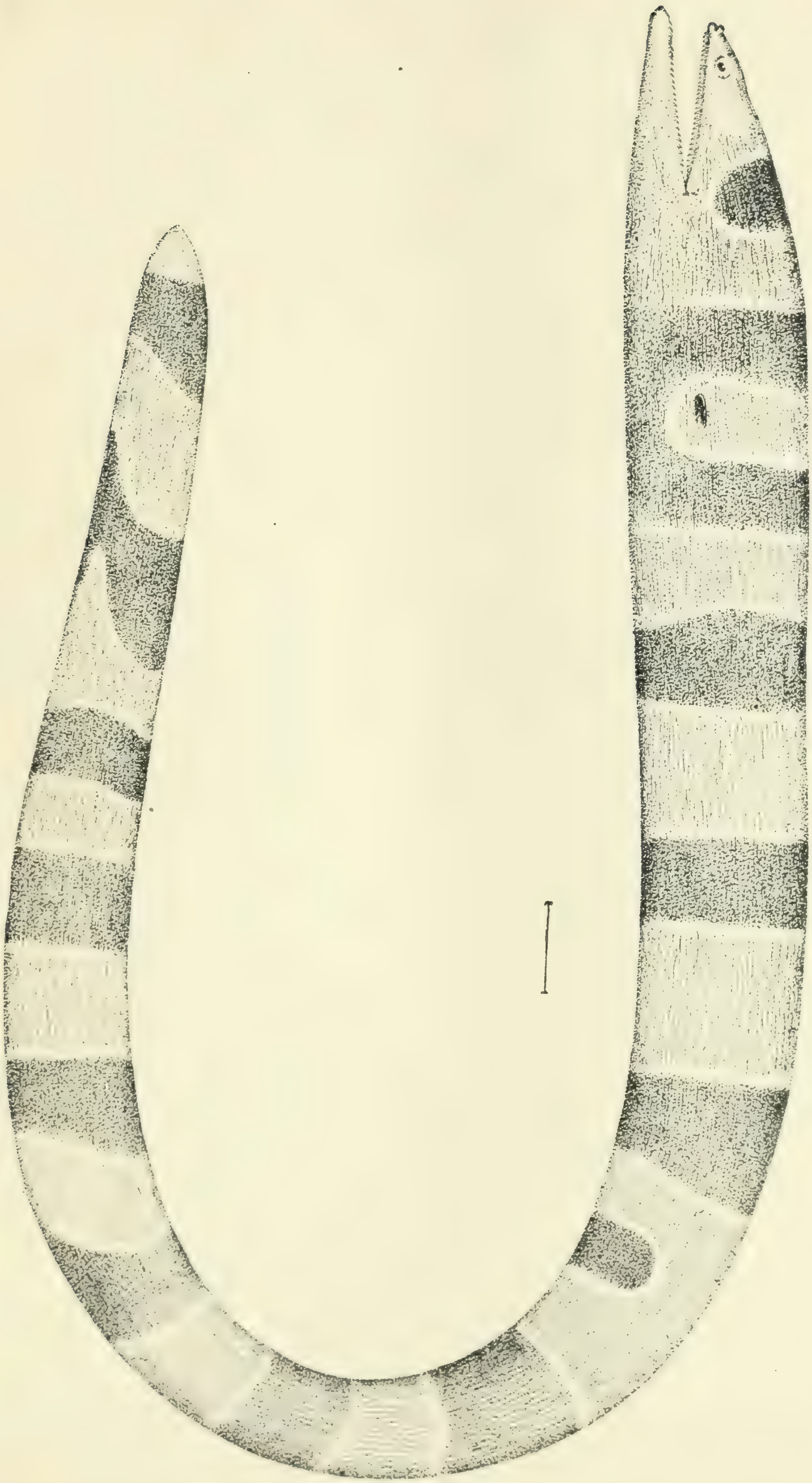
Genus 47. **Synaphobranchus** Johnson.

126. *Synaphobranchus pinnatus* Gronow. A, P.

Genus 48. **Histiobranchus** Gill.

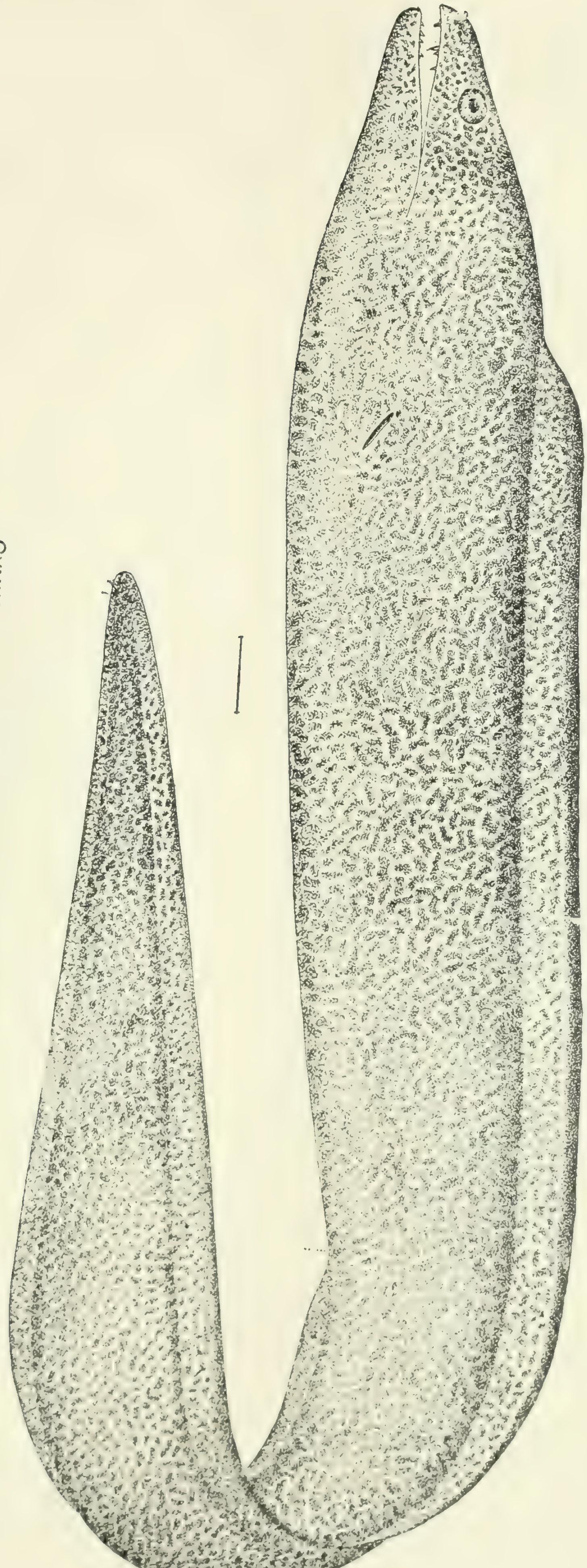
127. *Histiobranchus bathybius* Günther. P.
128. *Histiobranchus infernalis** Gill (probably identical with *H. bathybius* Günther). A.

PLATE LXXIII.



CHANNOMURÆNA VITTATA.

PLATE LXXIV.

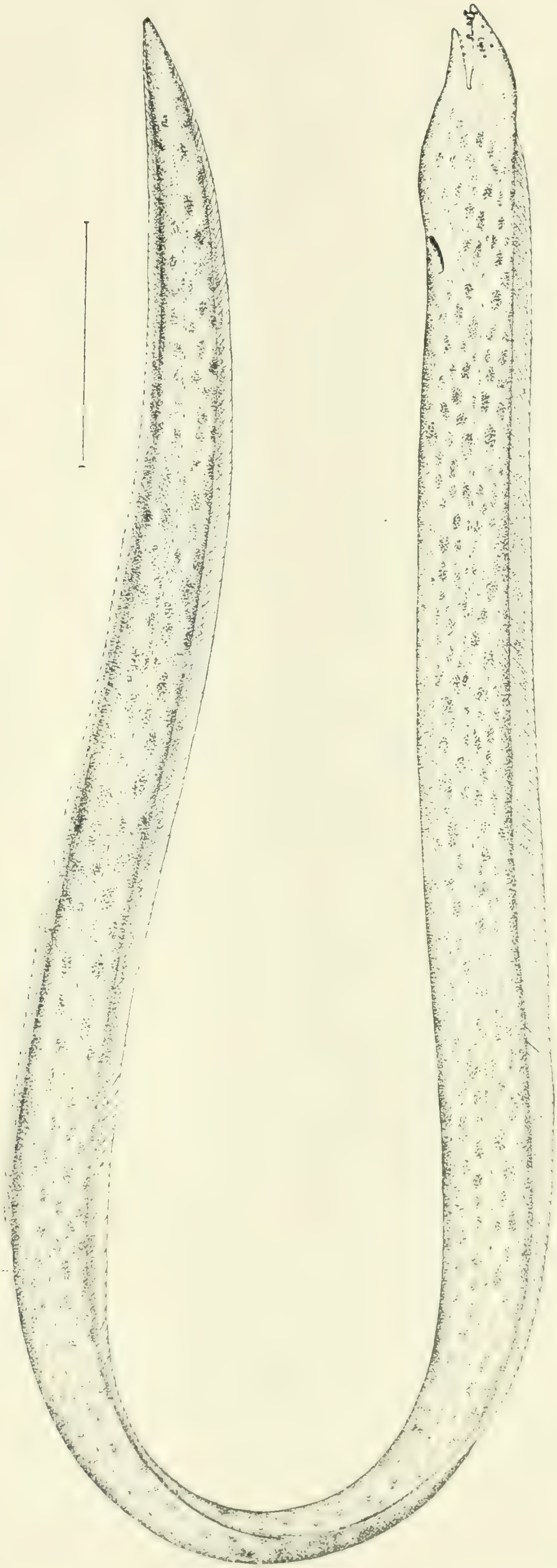


GYMNOTHORAX MORINGA. Common Moray; Hamlet

PLATE LXXV.

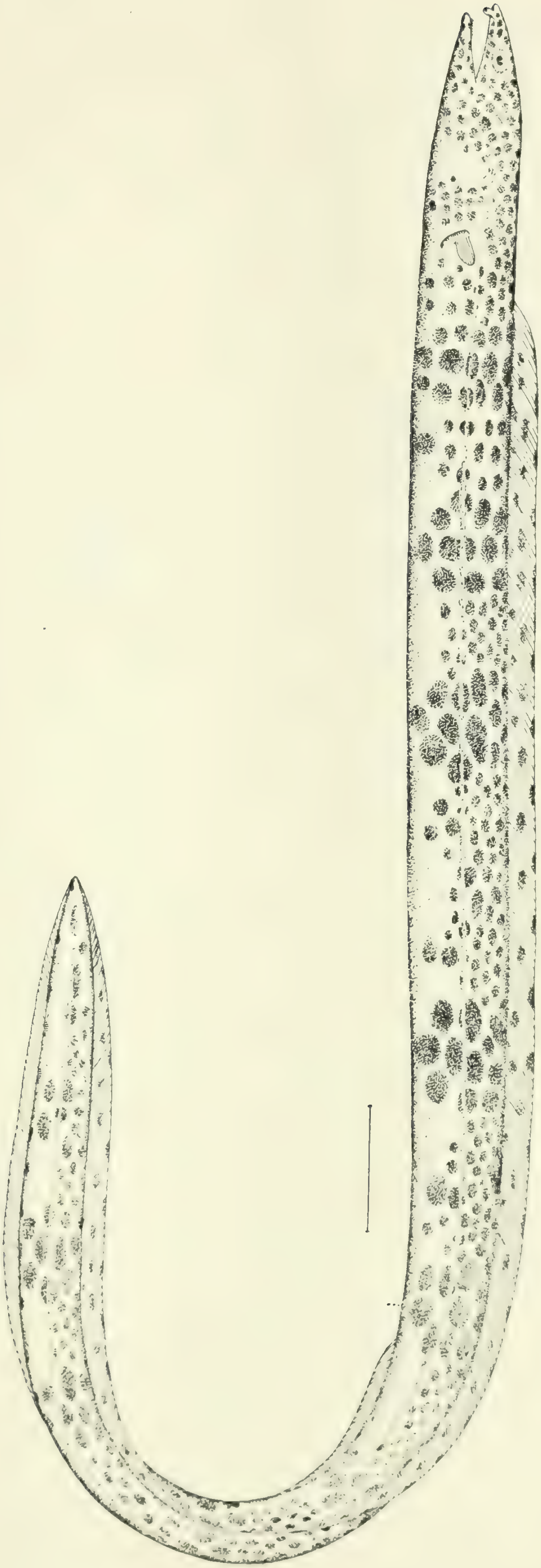
MURÆNA INSULARUM.

MYRICHTHYS TIGRINUS.



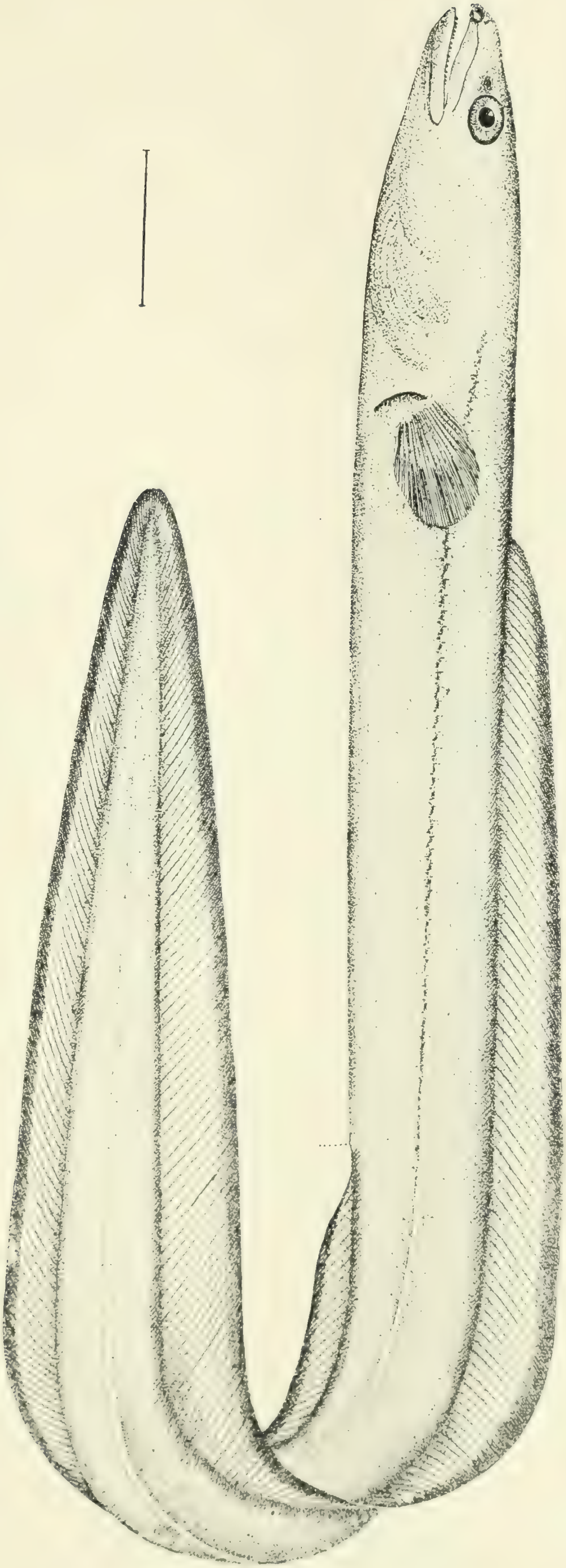
CALLECHELYS MURÆNA.

PLATE LXXVIII.



QUASSIREMUS EVIONTHAS.

PLATE LXXIX.



LEPTOCEPHALUS CONGER. The Common Conger; Conger Eel.

PLATE LXXX.

ANGUILLA CHRYSYPA. The American Eel.

10.—THE CHEMICAL COMPOSITION AND NUTRITIVE VALUES OF FOOD-FISHES AND AQUATIC INVERTEBRATES.

By W. O. ATWATER, PH. D.,
Professor of Chemistry in Wesleyan University, Middletown, Connecticut.

INTRODUCTION.

The Reports of the U. S. Commissioner of Fish and Fisheries for 1880 (Washington, 1883) and 1883 (Washington, 1885) contain preliminary accounts of the progress of an investigation of the chemical composition and nutritive values of American food-fishes and aquatic invertebrates, the details of which are given herewith. The investigation in its present status includes: (1) Chemical analyses of the flesh of American food-fishes and invertebrates; (2) experiments upon the digestibility of the flesh of fish; (3) studies of the chemical constitution of the albuminoids of the flesh of fish.

Analyses have been made of the flesh of 123 specimens of American fishes belonging to 52 species; of 3 specimens and 2 species of European fishes, and of 64 specimens representing 11 species of American mollusks, crustaceans, etc. Two of the European specimens were of a species included in the American fishes. The total number of specimens of fish analyzed is, therefore, 126, belonging to 53 species. These, with the invertebrates, make 190 specimens, belonging to 64 species. Since, in many cases, analyses were made of more than one specimen, the actual number analyzed is larger than these figures imply.

Nearly 1,000 different species of fish are used for food in the United States. When we consider that almost no other analyses of American food-fishes have been made (I am aware of but two); that different specimens of the same species vary considerably in composition, so that several analyses of each are necessary to show the ranges of variation and the average composition under different circumstances of locality, season, size, age, sex, etc.; and that, from both chemical and economical standpoints, studies of the constitution of the ingredients of the flesh and of other tissues are needed to make our information at all complete, it is evident that the work here reported can be regarded as only the beginning of a much-needed research.

Along with these studies, a series of analyses of meats, dairy products, and other food materials, animal and vegetable, have been under-

taken at the instance of the U. S. National Museum, to furnish data for illustrating and explaining its food collections. These analyses form an important economical supplement to the investigation herewith reported, because of the desirability of data for comparisons of fish with other foods. Some of the principal results are embodied in the tables of composition of food materials in Part II.

The studies of the digestibility of the flesh of fish were carried out in the physiological institute of the University of Munich. I am indebted to Professor Voit of that university, not only for the hospitalities of his laboratory but also for kind assistance. As the details of the experiments have been published elsewhere, only the main results are recapitulated here.

An investigation upon the constitution of the flesh of fish was begun in the physiological institute of the University of Heidelberg, where opportunities were furnished through the courtesy of Professor Kühne, to whom also I wish to express my indebtedness. The investigation has been continued in the laboratory of Wesleyan University, but has not reached that stage of completion which would make the publication of results satisfactory. Circumstances may hereafter permit its further prosecution, and the outcome may be combined with other studies, including those of dietaries of which fish forms or should form a part.

All of the work of investigation here reported, except that upon the digestibility of fish, was performed at Middletown, Connecticut, in the chemical laboratory of Wesleyan University.

While the work has been constantly under my immediate supervision, and much of it has been done by myself, the larger part of the details have been skillfully and faithfully performed by my assistants, Messrs. G. P. Merrill, W. H. Jordan, J. H. Long, Miles Beamer, E. B. Voorhees, E. W. Rockwood, and especially C. D. Woods. The last-named gentleman has performed the larger portion of the work of analysis and calculation of results besides contributing very materially to the elaborating of the methods of analysis and assisting in numerous other ways, including the preparation of diagrams and reading of proofs.

Thanks are due to Mr. F. T. Lane, of New Haven, Connecticut, Mr. J. F. Ely, of Baltimore, Maryland, to Messrs. Dorlon & Shaffer, of New York; and to Mr. E. G. Blackford, fish commissioner of the State of New York, for a large number of specimens of fish and invertebrates generously furnished for analysis, and for valuable information as well.

Especial thanks are due to Mr. Blackford, not only for a very considerable number of specimens and for information which was extremely helpful, but also for a gift of $100, which was used in defraying some of the incidental expenses of the analysis of invertebrates.

I wish also to acknowledge the generous contribution of Mr. A. R. Crittenden, of the firm of Wilcox, Crittenden & Co., of Middletown, Connecticut, of $100, which was used in defraying part of the incidental expenses of the analyses of fish.

PART I.

THE CHEMICAL COMPOSITION OF FOOD-FISHES, MOLLUSKS, CRUSTACEANS, ETC.

SECTION A.—AMERICAN FISHES.

1. NAMES OF AMERICAN FISHES AND NUMBER OF SPECIMENS ANALYZED.

In most of the tabular statements and discussions I have followed the arrangement of families given by Jordan and Gilbert in their Synopsis of the Fishes of North America, Bulletin No. 16 of the U. S. National Museum, 1883.

LIST OF SPECIES AND NUMBER OF SPECIMENS OF EACH.

The following is a list of the species analyzed, with the number of specimens of each, including both fresh and preserved fish:

	No. of specimens.
Acipenseridæ:	
Acipenser sturio oxyrhynchus, Sturgeon	1
Catostomidæ:	
Moxostoma velatum, Small-mouthed red-horse	1
Clupeidæ:	
Clupea harengus, Herring	2
pilchardus, Sardine	1
vernalis, Alewife	2
sapidissima, Shad	7
Salmonidæ:	
Osmerus mordax, Smelt	2
Coregonus clupeiformis, Whitefish	1
sp., *tullibee* or *artedi*, Ciscoe	1
Oncorhynchus chouicha, California salmon	5
Salmo salar, Salmon	7
subsp. *sebago*, Land-locked salmon	2
Salvelinus namaycush, Lake trout	2
fontinalis, Brook trout	3
Esocidæ:	
Esox lucius, Pike	1
reticulatus, Pickerel	2
nobilior, Muskellunge	1
Anguillidæ:	
Anguilla rostrata, Eel	2
Mugilidæ:	
Mugil albula, Mullet	1
Scombridæ:	
Scomber scombrus, Mackerel	10
Scomberomorus maculatus, Spanish mackerel	1
Orcynus thynnus, Tunny	1

	No. of specimens.
Carangidæ:	
Trachynotus carolinus, Pompano	2
Pomatomidæ:	
Pomatomus saltatrix, Bluefish	1
Stromateidæ:	
Stromateus triacanthus, Butter-fish	1
Centrarchidæ:	
Micropterus salmoides, Large-mouthed black bass	1
dolomieu, Small-mouthed black bass	1
Percidæ:	
Perca fluviatilis, Yellow perch	2
Stizostedion vitreum, Wall-eyed pike	1
canadense, Gray pike	1
Serranidæ:	
Roccus lineatus, Striped bass	6
americanus, White perch	2
Centropristis atrarius, Sea bass	1
Epinephelus morio, Red grouper	2
Sparidæ:	
Lutjanus blackfordi, Red snapper	3
Stenotomus chrysops, Porgy	3
Diplodus probatocephalus, Sheepshead	2
Sciænidæ:	
Sciæna ocellata, Red bass	1
Menticirrus saxatilis, Kingfish	1
Cynoscion regale, Weakfish	1
Labridæ:	
Hiatula onitis, Blackfish	4
Gadidæ:	
Phycis chuss, Hake	1
Brosmius brosme, Cusk	1
Melanogrammus æglefinus, Haddock	6
Gadus morrhua, Cod	10
Microgadus tomcod, Tomcod	1
Pollachius virens, Pollock	1
Pleuronectidæ:	
Hippoglossus hippoglossus, Halibut	5
Platysomatichthys hippoglossoides, Turbot	1
Paralichthys dentatus, Flounder	2
Pseudopleuronectes americanus, Flounder	1
Petromyzontidæ:	
Petromyzon marinus, Lamprey eel	1
Raiidæ:	
Raia sp., Skate	1

The whole number of specimens analyzed for this report thus amount to 123, belonging to 53 species. One specimen was, however, of French origin, while two specimens of European fish have been analyzed in connection with the present investigation, so that the latter actually includes analyses of 125 specimens. This report contains also an analysis of American halibut by Professor Chittenden. We have, therefore, analyses of 124 specimens of American fishes belonging to 53 species.

NAMES AND SYNONYMS.

Of the specimens of fishes analyzed in connection with the investigation whose details are reported here, a considerable number were found in fish markets in Middletown, Connecticut. These were mostly of common species whose names were well known to us. By far the larger number were supplied through the kindness of Mr. E. G. Blackford, fish commissioner of the State of New York, who gave with each specimen the common name, and in some cases the Latin name. Species with which we were not familiar, or the names of which were for other reasons a matter of doubt, were referred to Dr. W. N. Rice, professor of natural history in this college, who was so kind as to either identify them himself or have them identified under his supervision by an assistant or advanced student. Professor Rice tells me that the specific differences are sometimes difficult to distinguish in specimens that have been distorted in packing and transportation, so that it is not impossible that errors may have been made. I can not believe, however, that with the literature of the subject, and many typical specimens in the college museum, conveniently at hand and freely used, many or serious mistakes could have occurred.

There may perhaps be no obligation in a monograph on the chemistry of fish to lay much stress upon the natural history of the subject; but I had desired to group the specimens in accordance with their natural relationships, and especially to put the analyses of the same species together, thinking that such a comparison of the chemical characters would be of interest, and hence desired to have the classification as correct as might be. In the following list of American fishes the names given in Dr. Jordan's Catalogue of Fishes of North America* have been adopted.

I am under obligations not only to the gentlemen named, but also to Prof. D. S. Jordan and Dr. T. H. Bean for assistance in the preparation of the list of synonyms.

In preliminary reports of the present investigation published in the reports of the U. S. Commissioner of Fish and Fisheries for 1880 and 1883, some of the Latin names employed differ from those here given. The list contains the names used in this report with Latin and English synonyms. Where the names in former reports differ from those here used they are included in the list of synonyms. The English names are mostly those given by Jordan and Gilbert. The French and German names are taken from Günther's Catalogue, except that one or two of the German names are as given by Linné.

*Report U. S. Commissioner of Fish and Fisheries for 1885, pp. 787-973.

LIST OF NAMES OF AMERICAN FISHES ANALYZED.

Acipenser sturio oxyrhynchus Mitch. Common sturgeon; French, Esturgeon; German, Stör. No. 238.

Moxostoma velatum Cope,* *Moxostoma velata* Jordan, Man. Vert. Small-mouthed red-horse; Buffalo fish. No. 258.

Clupea harengus Lin. Common herring; Whitebait (young). French, Hareng; German, Hering. Nos. 33, 47.

Clupea pilchardus Walb. Sardine; Pilchard. French, Sardine; German, Pilchard. No. 87.†

Clupea vernalis Mitchill; *Clupea mattowocca* Günther, Study of Fishes, p. 659; *Pomolobus vernalis*, Goode & Bean. Alewife; Branch herring; Gaspereau. Nos. 5, 220.

Clupea sapidissima Wilson, Günther, Study of Fishes, p. 659. *Alosa sapidissima* Cope. Common shad. Nos. 6, 10, 32, 212, 221, 245, 249.

Osmerus mordax Mitchill (Gill); *O. viridescens* Günther. American smelt. Nos. 23, 207.

Coregonus clupeiformis Mitchill (Milner); *C. albus* Günther. Common whitefish. No. 18.

Coregonus sp. (*tullibee* or *artedi?*‡); *Argyrosomus* Jor., Man. Vert. Cisco; Lake herring. No. 111.

Oncorhynchus chouicha (Walb.) Jor. & Gil.; *O. quinnat*, Günther. California salmon; Quinnat salmon; King salmon; Columbia salmon; Sacramento salmon; Chinook salmon; Tyee salmon; Fall salmon (male); Spring salmon; Winter salmon; Saw-Kwey; Chouicha. Nos. 27, 29, 96, 233, 241.

Salmo salar Linn. Common Atlantic salmon. Fr., Saumon; Ger., Lachs, Salm. Nos. 14, 35, 36, 77, 78, 279, 280.

Salmo salar subsp. *sebago* Girard. Land-locked salmon. Nos. 40, 41.

Salvelinus namaycush (Walb.) Goode; *Salmo namaycush* Günther; *Cristivomer namaycush* Jor., Man. Vert. Lake trout; Mackinaw trout; Great Lake trout; Longe (Vermont); Togue (Maine). Nos. 17, 255.

---

* This specimen was sent to us by Mr. Blackford, fish commissioner of the State of New York, as a buffalo fish from Cleveland, Ohio. The natural inference would be that it came from somewhere in that region, perhaps from Lake Erie or one of the Great Lakes. It was here identified as *Myxostoma velata* Cope, seeming to conform more closely to the description of that species as given by Jordan, Manual of Vertebrates, 1880, than to the closely related *Ictiobus*, to which the buffalo fishes proper belong. I understand that the differences between this and some of the species of *Ictiobus* are such that one not a specialist in ichthyology might mistake the one for the other. That any such mistake could have been made, however, seems to me very improbable, as this specimen was examined with care. I have, however, changed the spelling to *Moxostoma*, thus following Jordan & Gilbert's Synopsis since published.

† This specimen was, or at least purported to be, of French origin, and should more properly be classed with European specimens. It was included in the tables of American fishes because analyzed with them.

‡ This specimen was sent by Mr. Blackford as Cisco, or Lake herring, *Argyrosomus tullibee*, from Lake Erie. The name *A. tullibee* is given by Jordan, Man. Vert., 1880; but Jordan & Gilbert in their Synopsis designate the same species as *Coregonus tullibee*, Tullibee, Mongrel Whitefish. Dr. Bean informs me that this is rare, and I find in Jordan and Gilbert's Synopsis the Lake herring or Cisco designated as *C. artedi*. The descriptions of the two species represent them as very similar, and it is not at all impossible that our specimen may have been *artedi* rather than *tullibee*. I do not, at this writing, find any note of the identification of the specimen here, and consider it safest to designate it as *Coregonus* species, leaving the specific name in question.

Salvelinus fontinalis (Mitch.) Gill & Jor.; *Salmo fontinalis* Günther. Brook trout; Speckled trout. Nos. 24, 254, 256.

Esox reticulatus Le Sueur. Common Eastern pickerel; Green pike. Nos. 100, 224.

Esox lucius Linn. Pike, Pickerel* (Vermont, New York, etc.). Fr., Brochet; Ger., Hecht. No. 98.

Esox nobilior Thompson; *Esox estor* Günther. Mascalonge; Muskallunge; Musquallonge; Maskinonge. No. 45.

Anguilla rostrata Le Sueur; *A. bostoniensis* Günther. Common eel. Nos. 4, 217.

Mugil albula Linn.; *M. lineatus* Günther. Striped mullet. No. 126.

Scomber scombrus Linn.; *Scomber scomber* Günther. Common mackerel. Fr., Maquereau vulgaire; Ger., Makrele. Nos. 8, 13, 30, 39, 42, 94, 95, 219, 230, 261.

Scomberomorus maculatus (Mitch.) Jor. & Gil.; *Cybium maculatum* Günther. Spanish mackerel. No. 43.

Trachynotus carolinus (Linn.) Gill; *T. pampano* Günther. Common pompano. Nos. 234, 263.

Pomatomus saltatrix (Linn.) Gill; *Temnodon saltator* Günther. Bluefish; Greenfish; Skipjack. No. 12.

Stromateus triacanthus Peck; *Poronotus triacanthus* Gill. Butter-fish; Dollar-fish; Harvest-fish; La Fayette. No. 90.

Micropterus salmoides (Lac.) Henshall †; *M. salmoides* Jor. & Gil.; *Huro nigricans* Günther. Large-mouthed black bass; Oswego bass; Green bass; Bayou bass. No. 53.

Micropterus dolomieu Lac. †; *M. salmoides* Jor., Man. Vert; *Grystes fasciatus* Günther; *M. achigan* Rafinesque. Small-mouthed black bass. No. 91.

Perca lutea Raf. ‡ (vide Günther, Study of Fishes, p. 375); *Perca americana* Schranck. Yellow perch; American perch; Ringed perch; Perch. Fr., Perche; Ger., Barsch. Nos. 127, 208.

Stizostedion vitreum (Mitch.) Jordan & Copeland; *Lucioperca americana* Günther. Pike perch; Wall-eyed pike; Dory; Glass-eye; Yellow pike; Blue pike; Jack salmon. No. 52.

Stizostedion canadense (Smith) Jor.; *Lucioperca canadensis* Günther. Pike perch; Gray pike; Sauger; Sand-pike; Horn-fish. No. 257.

Roccus lineatus (Bloch) Gill; *Labrax lineatus* Günther. Striped bass; Rockfish; Rock. Nos. 7, 19, 225, 237, 248, 260.

Roccus americanus (Gmel.) Jor. & Gil.; *Morone americana* Gill; *Labrax rufus* Günther. White perch. Nos. 44, 46.

Serranus atrarius (Linn.) Jor. & Gil.; *Centropristis atrarius* Günther. Sea bass; Blackfish; Black sea bass. No. 251.

Epinephelus morio (Cuv.) Gill; *Serranus morio* Günther. Red grouper. Nos. 114, 271.

Lutjanus blackfordi Goode & Bean. Red snapper. Nos. 20, 26, 242.

Stenotomus chrysops (Linn.) Bean; *Pagrus argyrops* Günther; *Stenotomus argyrops* Gill. Porgy; Porgee; Scup; Scuppaug. Nos. 15, 31, 262.

Diplodus probatocephalus (Walb.) Jor. & Gil.; *Sargus ovis* Günther. Sheepshead. Ger., Schafbrassen. Nos. 48, 250.

---

* About Lake Champlain, in New York and Vermont, and, for aught I know, elsewhere, the *Esox lucius* is popularly known as "pickerel." This specimen was called by Mr. Blackford, from whom it was received, "Large pickerel."

† These two, *M. salmoides* and *M. dolomieu*, have occasioned us some perplexity. (Compare Jordan, Man. Vert., and Jor. & Gil., Synopsis.) They were received at different times and identified as above stated; one may have been mistaken for the other, but this seems to me so improbable that I use the names as given.

‡ Our common yellow perch has been designated in previous reports as *P. fluviatilis*, but I find that authorities (Jor. & Gil., Synopsis 524) have come to regard it as distinct from the European species of that name.

Sciæna ocellata (Linn.) Günther; *Sciænops ocellatus* Gill. Red bass; Channel bass; Red-horse. No. 270.

Menticirrus saxatilis (Bl. & Schn.) Jor.; *Umbrina nebulosa* Günther. Kingfish; Whiting; Barb. No. 252.

Cynoscion regale (Bl. & Schn.) Gill; *Otolithus regalis* Günther. Weakfish; Squeteague; Gray trout. No. 273.

Hiatula onitis (Linn.) Jor. & Gil. Blackfish; Tautog; Oyster-fish. Nos. 38, 205, 244, 269.

Phycis chuss (Walb.) Gill: *P. americanus* Günther. Hake; Codling; Squirrel-hake. No. 113.

Brosmius brosme (Müller) White. Cusk. No. 110.

Melanogrammus æglefinus (Linn.) Gill; *Gadus æglefinus* Günther. Haddock; Fr., Eglefin; Ger., Schellfisch. Nos. 16, 21, 88, 229, 259, 275.

Gadus morrhua Linn.; *Gadus callarias* Linn. Common cod. Fr., Morue; Ger., Dorsch (young and fresh), Stockfisch (dried), Leberdan (salted), Kabljau (old and fresh). Nos. 3, 11, 25, 34, 37, 79, 80, 206, 228, 243.

Microgadus tomcod (Walb.) Gill; *G. tomcodus* Günther; *Microgadus tomcodus* Gill. Tomcod; Frost-fish. No. 99.

Pollachius virens (Linn.) Günther; *Pollachius carbonarius* Gill. Pollock; Coal fish; Green cod. Fr., Colin; Ger., Kohler. No. 81.

Hippoglossus hippoglossus (Linn.) Jor.; *Pleuronectes hippoglossus* Günther; *H. americanus* Gill. Halibut. Fr., Fletan; Ger., Heilbutt. Nos. 1, 9, 28, 211, 218.

Platysomatichthys hippoglossoides (Walb.) Gill. Turbot; Greenland halibut. No. 94.

Paralichthys dentatus (Linn.) Jor. & Gil.; *Pseudorhombus dentatus* and *P. ocellaris* Günther. Common flounder. Nos. 2, 22.

Pleuronectes americanus (Walb.) Günther; *Pseudopleuronectes americanus* Bleeker. Winter flounder; Mud dab. No. 253.

Petromyzon marinus Linn. Lamprey eel; Great sea lamprey; Sea lamprey. Fr., Lamproie; Ger., Neunauge. No. 236.

Raia sp. Skate*. No. 247.

2. METHOD OF ANALYSIS OF THE FLESH OF FISHES.

During the course of the earlier part of the work here recorded a not inconsiderable amount of labor was devoted to the study of the methods of analysis. After a time the information thus obtained and, what is perhaps of as much consequence, the getting of the routine well in hand enabled us to turn out the analyses rapidly and with what seemed to us reasonable accuracy, at least so far as the principal determinations, moisture, nitrogen, ether extract, ash, sulphur, phosphorus, chlorine, etc., are concerned. The methods employed were as follows:

PREPARATION OF MATERIAL FOR ANALYSIS.

Separation of flesh (edible portion) from refuse (bones, skin, entrails, spawn, etc.).—The specimens as received at the laboratory were weighed. The flesh was then separated from the refuse and both were weighed. There was always a slight loss in the separation, due to evaporation, and to slimy and fatty matters and small fragments of the tissues that adhered to the hands and to the utensils used in preparing the sample. Perfect separation of the flesh from the other tissues was difficult, but

* This specimen consisted of only a part of the animal, left lobe of body, and we were unable to identify the species with certainty.

the loss resulting from this was small, so that, though the figures represent somewhat less than the actual amount of edible portion in the specimens, yet the amount thus wasted was doubtless less than would be left unconsumed at an ordinary table.

The reasons for rejecting the skin, which generally has considerable nutritive value, were that its chemical constitution is different from that of the flesh which we wished first of all to study, and that circumstances forbade our entering into the examination of the tissues other than flesh, valuable as their study would be. Nor is this omission entirely without warrant even from the economical standpoint, since, so far as I have observed in this country, the skin is not usually eaten. With the closer domestic economy that increased density of population must bring, people will become more careful to utilize such materials.

DRYING.

Partial drying.—In each case one or more samples of 50 to 100 grammes each, selected from different portions of the freshly chopped flesh, were weighed on a watch glass or small sauce plate and heated from 24 to 48 hours in an ordinary drying oven at a temperature of about 96° C., in a current of dry hydrogen. They were then allowed to cool and stand in the open air, but carefully protected from dust, for about 12 hours, when they were again weighed, pulverized, sifted through a sieve with circular holes .5 mm. in diameter, bottled, and set aside for analysis. The material in this condition constituted what was termed the "partly dried" sample. A few of the fattest samples, however, could not be worked through so fine a sieve. For these either a coarser sieve was used or the substance was crushed as finely as practicable and bottled without sifting.

Drying in hydrogen and in air.—The especial object in drying in hydrogen was to prevent possible oxidation of fats, whereby the latter would be rendered insoluble in ether or the accuracy of the calculations impaired. That this is at all necessary in animal tissues, or when it is necessary and when not, I am not prepared to affirm. In the early part of the work we arranged an apparatus for drying in hydrogen as a precaution, and although comparative trials in air and in hydrogen did not show large differences in results, the apparatus was so convenient that we have used it throughout the investigation in the partial drying of the material to be used in the determination of water, fat, nitrogen, and ash.

As drying in air is more convenient for larger quantities and answers perfectly well for certain determinations, as sulphur, phosphorus, and chlorine, a sufficient quantity of material for these determinations was prepared by drying in air. This was effected by weighing 200 grammes or more of the freshly chopped substance at the same time that the portion was taken for the drying in hydrogen. With the exception

that the drying was conducted in the air the treatment of the samples was the same as that described above.

Water and water-free substance.—For the complete drying, from 1 to 2 grammes of the partly dried material were weighed in small drying bottles and dried in hydrogen for two periods of about 2 hours each. It is extremely difficult to get an absolutely constant weight, though we find that the object is in most cases approximately attained in the above method. The total moisture and water-free substance are computed from the partial drying in hydrogen and from the final drying.

Examinations of the analytical details will show a number of cases in which the percentage of water-free substance in the portions used for the various determinations differs from those given in the water determination. This is due to the fact that some time intervened between the determinations, and that our experience shows that though reasonable care was used to procure bottles with well-fitting glass stoppers to hold the partly dried material, yet the moisture in the latter was likely to change on standing in the laboratory and that neither the use of rubber stoppers nor that of paraffin on the glass stoppers sufficed to prevent this so completely as to make us feel safe in using the substance after it had stood for some days, without redetermination of the water.

It is only just to say that although no little pains has been taken in this laboratory to learn how to make accurate determinations of water in animal and vegetable substance, we are far from satisfied with the success of our efforts. Indeed, I am inclined to regard this as one of the decidedly difficult determinations, so far as accuracy is concerned.

NITROGEN, PROTEIN, ALBUMINOIDS, ETC.

The nitrogen was determined in the partly dried substance (partial drying in hydrogen) by the soda-lime method.

It is customary to compute the albuminoids or protein (nitrogenous substances) by multiplying the nitrogen by 6.25. In our analyses this factor has, in general, appeared to be very nearly correct. I have thought it best, for the present purpose, to state the percentages of nitrogen and of protein as calculated by multiplying these by 6.25, and also to estimate the "albuminoids, etc." by difference. For the latter, the remainder left after subtracting the sum of ether extract and ash from the water-free substance, or the sum of water, ether extract, and ash, from the fresh substance, is used. This is not absolutely correct, but is more nearly so than the product of nitrogen by 6.25 would be.

The importance of correct estimation of the nitrogenous matters led us to spend a not inconsiderable amount of time in the study of the sources of error and means of avoiding them, especially in the use of the soda-lime method for determining nitrogen in animal tissues.

Sources of error in the soda-lime method and means for avoiding them.—As the investigations of these questions have been published in de-

tail elsewhere,* a recapitulation of the results and conclusions will perhaps suffice here. For this purpose I quote from an article in the American Chemical Journal: †

The experimental and other considerations presented in this and the previous articles on the determination of nitrogen by soda lime may be conveniently summarized, after first recalling the probable reaction by which the nitrogen is changed to ammonia and the principal sources of error in the operation:

(1) It seems decidedly probable that the change of nitrogen to ammonia is effected by union, at high temperature, with water vapor yielded by the soda lime (or slaked lime in case the latter is used). It is essential that the contact between nitrogenous distillation products and water vapor be sufficient and at not too high or too low temperature to insure conversion of all the nitrogen to ammonia, and that the ammonia be not dissociated or oxidized. The main objects, then, are to secure complete ammonification and to avoid dissociation and oxidation.

(2) The chief difficulty in the way of complete ammonification of protein compounds appears to be the formation of gases which do not readily yield their nitrogen to be united with the hydrogen of the water vapor. With certain other classes of nitrogenous compounds, as leucine and its congeners, alkaloides, amines, and amido and azo compounds, this difficulty is greater and sometimes apparently insuperable. The tendency of protein compounds to be decomposed by heat and other agencies into leucine, amines, etc., appears to explain the difficulty frequently found in getting all their nitrogen into the form of ammonia by heating with soda lime. The evident means to secure complete ammonification must be sufficient contact with soda lime at proper temperature.

(3) The danger of dissociation of ammonia evidently increases with increase of temperature and time of exposure, and is probably diminished by presence of water vapor and other diluting gases. If this be so, the danger will be avoided by measurably rapid combustion at not too high heat, and by keeping the ammonia in contact with sufficient moisture from the soda lime until it leaves the heated tube.

(4) Leaving out of account substances such as nitrates, nitro-compounds, etc., whose nitrogen is imperfectly converted into ammonia by soda lime, even in the presence of organic matter, and assuming palpable errors of manipulation to be avoided, such as (*a*) loose packing of asbestos plug, which would allow particles of soda lime to be swept into the acid bulb; (*b*) heat at anterior end of the tube so low as to permit ammonia to be retained with moisture about the cork, or so high as to char the cork and give rise to acid or alkaline distillation products; (*c*) use of soda lime containing nitrates or nitrites, which may, according to circumstances, either furnish nitrogen to be transformed into ammonia or oxygen to burn the ammonia formed from the nitrogen of the substance; (*d*) use of distilled water containing ammonia for rinsing the acid bulb; (*e*) imperfectly cleaned or incorrectly calibrated burettes; the principal sources of error above discussed involve loss of nitrogen, and may be recapitulated thus:

I. Loss from imperfect ammonification of the nitrogenous substance, due to—

a. Incomplete decomposition of the substance, part of the nitrogen being (from coarseness of the particles of the substance, imperfect mixing with the soda lime, insufficient heat, or other cause) left behind in the charred residue.

b. Change of nitrogen into compounds other than ammonia, either such as may remain in the tube, *e. g.*, cyanogen, or volatile distillation products which escape

* Notes on the soda-lime method for determining nitrogen, W. O. Atwater and C. D. Woods, Am. Chem. Journal, vol. 9, p. 311. Note on the absorption of ammonia by acid solution in nitrogen determinations with soda lime, I. S. Haynes, *loc. cit.*, 10, p. 111. On certain sources of loss in the determination of nitrogen by soda lime, W. O. Atwater and E. M. Ball, *loc. cit.*, 9, p. 319. On sources of error in determinations of nitrogen by soda lime, and means for avoiding them, W. O. Atwater, *loc. cit.*, 10, pp. 197 and 262.

† Am. Chem. Journal, vol. 10, p. 277.

ammonification and pass through the acid solution unabsorbed, or, if absorbed, are not accurately determined by the titration or other means used to find the amount of nitrogen in the solution.

c. Escape of nitrogen in the free state.

II. Loss of ammonia through—

a. Dissociation at high heat in the combustion tube.

b. Oxidation by air present in the tube before, or introduced in aspirating to wash out ammonia after the combustion.

c. Neutralization by acid products, *e. g.*, of sugar, where the latter is used in the combustion.

d. Incomplete absorption by the acid solution.

(5) Complete decomposition of the substance has, in our experience, been readily secured by pulverization fine enough for it to pass through a sieve of 1 mm. aperture; thorough mixing with soda lime; avoiding the shaking by which the particles gather at the top of the soda lime; and heating to low redness.

(6) With sufficient soda lime, not too dry, we have found no reason to fear the formation of cyanides, nor have we been able to obtain any indication of the escape of free nitrogen when the operation is properly conducted, although it might, perhaps, occur by oxidation of ammonia if there were nitrates or nitrites present, or if aspiration with air were done while tube and contents are hot. Turning off the flame before aspirating has, in our experience, sufficed to avoid oxidation by air. At least, if ammonia has been oxidized, the quantity has been too small to be detected.

(7) When sugar is used, acid products may be formed in quantities large enough to impair the accuracy of the determinations. With ordinary animal and vegetable protein compounds, provided enough soda lime is employed, the use of hydrogen, or sugar, or other substances for supplying gases, either to expel air, or to yield nascent hydrogen to form ammonia with the nitrogen, or to dilute the ammonia and prevent dissociation, or to wash out the ammonia, appears to be unnecessary. The danger of loss by incomplete absorption of the ammonia by the acid solution appears to be very small indeed, even when the development of gases is very rapid, provided sufficient acid solution be used.

The chief sources of loss appear to be from incomplete ammonification and from dissociation of the ammonia formed.

(8) The first of these two difficulties is a serious one. With protein compounds, the great trouble is evidently the formation of volatile decomposition products which do not readily yield their nitrogen to form ammonia with hydrogen. This is easy to understand when we consider that protein compounds are prone to yield cleavage products such as leucine and its congeners, compounds allied to the alkaloids, amido compounds, etc.; and that it is very difficult to get all the nitrogen of these latter into the form of ammonia with soda lime, evidently because of their proneness to form compounds that resist the ammonifying action.

With alkaloids and allied compounds, leucine and other amido compounds, amines, and azo and nitro compounds, complete ammonification is not always effected even with the utmost care. Concerning peptones our experience does not enable us to speak; but for the protein of ordinary animal and vegetable substances, including casein, proper precautions appear to insure complete ammonification of the nitrogen. The important condition appears to be sufficient contact with heated soda lime (*i. e.*, with water vapor at high temperature).

This contact is best secured by (*a*) intimate mixture of substance with soda lime; (*b*) close packing so as to avoid open space inside the tube; (*c*) providing a reasonably long anterior layer of soda lime; (*d*) heating this latter to dull redness before bringing the heat to bear upon the substance, and keeping it hot until the combustion is done. In order to insure the maximum of surface for contact it is well to have the anterior layer consist of coarse particles of soda lime containing enough lime to prevent fusing together. It is possible that too long heating may result in expelling the water from the soda lime, so that there will not be enough in the latter part of the operation to insure complete ammonification.

Though it is desirable to avoid coloration and turbidity of the acid solution, these do not necessarily imply incomplete ammonification, nor does their absence prove perfect combustion. With proper care to insure contact between soda lime and substance, we have almost never found the solution so colored as to seriously interfere with titration.

(9) Ammonia may be dissociated and nitrogen lost by either too high heating or by conducting the operation so slowly as to leave the ammonia exposed for a long time to heat. It seems probable that the presence of water vapor, as of other gases, would tend to prevent dissociation of the ammonia, and that the danger of long heating may be partly due to reduced supply of moisture from the anterior layer of soda lime after the latter has been heated for some time.

(10) A vacant space in the tube (channel as ordinarily recommended) may cause serious loss. This loss is greater the higher the temperature and the longer the time of combustion. It is probably due not only to incomplete ammonification of distillation products through lack of contact with the soda lime, but also to dissociation of ammonia. With the channel the flow of the gases is slower and they are exposed to heat longer than when the tube is packed full. Add the possible lack of water vapor when the heating is long continued, and the loss by dissociation is very clearly explained. When the tube is closely packed, the flow of gases reasonably fast, and the operation conducted at a temperature sufficient to heat the tube only to dull redness, there appears to be no considerable loss by dissociation, even with a long anterior layer (20 or 30 cm.) of soda lime.

Concerning reagents, apparatus, and manipulation, a few words will suffice.

1. *Soda lime.*—The soda lime made by mixing one part of ordinary caustic soda with two and a half parts of quicklime by the process described,* costs very little for materials and labor, and serves the purpose very satisfactorily. In sifting it is conveniently divided into a finer portion to be mixed with the substance, and into coarser particles to be used for the anterior layer. It bears heating without fusing so much as to leave any considerable open space in the tube if closely packed at the outset. Varying proportions of soda lime, from one part to two and one-half parts of lime to each part by weight of soda, have made no difference in the results of the analyses. We have obtained equally good results with the mixture of sodium carbonate and slaked lime as described by Johnson, and see no reason why slaked lime as recommended by him should not be generally efficacious as it has proven in the cases cited by him and in those tried by ourselves. Our reason for adhering to the ordinary soda lime has been the impression that by filling the anterior portion of the tube with coarse particles of the rather difficultly fusible material, more complete contact is insured between nitrogenous distillation products and the heated water vapor from the soda lime. The old theory that enough soda should be mixed with the lime to make the mixture easily fusible does not stand the test of experience.

In testing the purity of soda lime by sugar, as is sometimes recommended, there is danger of error both from the presence of nitrogen in the sugar and from formation of acid distillation products.

2. *Tubes and charging.*—For ordinary combustions, tubes of from 35 to 40 cm. in length do very well. The method of charging the tube upon which we have gradually settled, after numerous trials with tubes of different lengths and charged in different ways, is explained in the accompanying tabular statement:

	Centimeters.
Length of tube	40
Asbestos and fine soda lime	4
Mixture, fine soda lime and substance	16
Rinsings, fine soda lime	4
Anterior layer, coarse soda lime	12
Asbestos, open space, plug	4

* Amer. Chem. Journal, 9, 312.

With a shorter tube the divisions may be made proportionately shorter. We intend to have at least forty parts by weight of fine soda lime for every part of substance in the "mixture." About 0.4 and 0.6 gramme of flesh (water free), or corresponding amounts of other materials, we find convenient. The importance of fine pulverization of substance, intimate mixture with soda lime, filling the tube compactly so as to have no channel, avoiding the shaking by which particles of the substance might be brought to the top of the soda lime, and heating until no charred material is left, is insisted upon. An anterior layer of coarse soda lime, 12 cm. long, has proven very satisfactory. The anterior layer should be well heated before the heat is applied to the mixture of soda lime and substance, and kept hot until the combustion is done.

3. *Heat and time of combustion.*—A "low red" heat ordinarily suffices. Heating to bright redness brings danger of loss of ammonia by dissociation, though in our experience, when the tube is closely packed and the operation not too slow, we have found practically no difficulty in getting all the nitrogen as ammonia even at high heat. But with a channel in the tube the loss by high heating has been considerable.

Ordinarily, three-quarters of an hour is ample for the combustion, and an hour the extreme limit, according to the experience in this laboratory. Rapid combustion is less and long heating more dangerous than is frequently taught. With an ordinary Knop and Arendt (four bulb) bulb apparatus containing 10 cc. of acid solution, of which little over half was required to neutralize the ammonia, the ammonia was completely absorbed even when the combustion lasted only 12 minutes. Serious loss may result from too long heating, especially if there be open space in the tube or the temperature is high.

4. *Determination of the ammonia.*—In the combustion of ordinary protein compounds with the precautions stated above, practically all the nitrogen is converted into ammonia, and its determination by titration is easy. We find it well, however, to use concentrated solutions and to avoid excess of water in rinsing out the bulbs. The quantity of concentrated acid solution required is small and the tension in the combustion tube during the heating consequently slight, which is a convenience; while, with the small quantity of solution in titrating, the color reaction is sharp and the determination easy and accurate. Freshly prepared cochineal solution is the most satisfactory indicator we have found. Very narrow burettes, in which 10 cc. occupy from 30 to 40 cm., have decided advantages for convenience and accuracy when concentrated solutions are used.

Accuracy of measurement of solutions.—The danger of error in measuring the standard acid and alkali is greater than is sometimes supposed. The results of our observations may be briefly summarized:*

(1) Leaving temperature out of account, uniformity and accuracy of delivery depend upon the completeness with which the liquid is removed from the inner walls of the tube. The amount of adhering liquid is greater the larger the extent of the interior surface to be drained; the greater the amount of dirt, grease, etc., on this surface; the more rapid the outflow and the shorter the time allowed for the after flow, *i. e.*, for the adhering liquid to drain down. When the tubes are not clean and the delivery is rapid the amount of adhering liquid may be so large and so variable as to materially affect the measurements. But with clean, narrow tubes and fine jets the uniformity, and hence the accuracy, are all that could be desired.

* See article on Burettes and Pipettes by W. O. Atwater and C. D. Woods, Journal of Anal. Chem., vol. I, p. 373.

(2) With a float, or, as is more convenient, a simple device such as a black and white reflecting surface of paper held behind the burette, and sights to insure that the level of the eye shall be the same as that of the meniscus, or, indeed, by using proper care without float or other help, reasonably accurate reading is easy even with burettes of ordinary width.

(3) With very narrow burettes, well cleaned and provided with fine jets, it is easy without float, reflector, sights, or other helps for reading, to make measurements with a probable maximum error of .001 to .002 cc. in 10 cc. For accurate measuring of small quantities of solutions, therefore, the narrow burette is decidedly advantageous.

In the determinations of nitrogen by the soda-lime method we have found it convenient to employ quite concentrated solutions of standard acid. For this we have, after some years' experience, settled upon a 10 cc. burette of about 5 mm. internal diameter graduated to .05 cc. For standard alkali, which we make more dilute, we employ a somewhat wider burette. Since the narrow burettes of ordinary thickness are apt to get broken, we find it advisable to have them made of thick glass.

For the ordinary work of analysis, burettes of the usual width (when they are kept clean and when the measurements by which they are calibrated and those in the ordinary routine of analysis are made in the same way) give tolerably good results. It is only when especial accuracy is desired that the narrow burettes and the precautions above suggested (regarding cleanness of the burettes and either slow drawing off of the solution through narrow jets or other means to avoid error from the afterflow) are needed. Of course, the greater dilution of solution which may be used in the wider burettes compensates more or less completely for the larger error involved in their use. But where, for the sake of sharpness of the color reaction or for other reasons, as, for instance, to avoid pressure on the combustion tubes, it is desirable to use very small quantities of concentrated solutions, the narrow burettes offer decided advantages.

Since most of the analyses were made, the method of Kjeldahl has come into use, and is now employed in this laboratory in preference to the soda-lime method, though we find it advantageous to use the latter from time to time as a check.

FATS, ETHER EXTRACT.

The fats were extracted with ether, which, after various trials with chloroform, benzine, and carbon disulphide, we are persuaded is the most convenient solvent for the purpose.

The determinations were made in the material which had been dried in hydrogen. Generally, from 0.3 to 1.0 grammes was used for the extraction. The operation was conducted in an apparatus similar to that described by Johnson.* The corks and filter paper were always treated

*Am. Jour. Sci., 13, 1887, 190.

with ether before using. We have found it convenient, however, to duplicate the apparatus, using several at once. A rectangular box of zinc or galvanized iron, 120 cm. long, 20 cm. wide, and 25 cm. high, and provided with eight pipes of block tin which serve as worms, makes a very good cooler for the ether. The radiation of heat from the water is perhaps sufficient to keep it cool enough to condense the ether, but we generally have a current of water running through the cooler when in use.

The point at which the extraction is completed we have not always found easy to determine. The methods ordinarily recommended, of evaporating a drop of the ether after it percolated through the substance, either on a piece of paper or on a clean watch-glass, and noting whether a transparent spot or a residue remains, have not in our experience been satisfactory. We prefer to continue the extraction for such time as experience has indicated to be usually sufficient, and then remove the flask and substitute another, repeating this latter operation until the new flask shows no gain in weight after the extraction has been continued for some time. When the extraction is believed to be complete, the apparatus is taken off from the condensing tube, the inner tube holding the substance is taken out, a test tube substituted, the apparatus put back in place, and the ether in the flask is again warmed, allowed to condense and run back into the test tube, and thus most conveniently recovered for subsequent use. The small portion of ether still adhering to the extract in the flask is removed by heating in a current of hydrogen in the apparatus used for drying.

What other substances besides fats are thus extracted from the flesh of fish, oysters, etc., is a matter which I have not investigated, contenting myself for the present with simply calling the material extracted by ether, ether extract. As the analytical details show, the material used for fat determination was dried in the hydrogen before extraction with ether. By this means two possible sources of error are avoided, to wit:

(1) Certain fatty substances, as is well known, are rendered insoluble or very difficultly soluble in ether by being heated in air. This alteration, due, I suppose, to oxidation, is very marked in many vegetable substances. Thus I have found the larger parts of the fats of linseed, maize, and grasses to be rendered insoluble in this way. To what extent any of the fats of the animal tissues which we have analyzed would be thus affected is a matter which I regret to have been unable thus far to study. That the error by drying in air would be large seems to me improbable.

(2) When the material extracted contains considerable quantities of water, or when commercial ether containing water is used, substances other than fats may possibly be dissolved. When and how greatly the presence of water would affect the results I can not tell, though I do not believe the error would be great in such substances as we are here dealing with.

The ether extract was nearly always more or less colored. How far

this was due to chemical or physical changes in the fats, and how far to coloring matters extracted with them, I can not say.

As regards the difficulty of extracting with ether, our experience shows that many of the vegetable fats, as those of maize, wheat, etc., are easily extracted, while those of animal tissues are often more difficult to get into solution. The fats, or, more properly, the materials soluble in ether, are more readily extracted from oysters, clams, lean beef, etc., than from the flesh of the fatter fish and the fatter meats. In general, the greater the percentage of fat in a substance the more difficult the removal of the last traces. Mr. Woods remarks that "the flesh of eels was the hardest material to extract I have ever met." I should say that even the flesh of eel could hardly be much more difficult than the yelk of eggs, which, however, is of different composition. It is, I think, very important that the material to be extracted be fine, especially when it is hard and dry, as is often the case with partly dried flesh.

After the experience which we have had in extracting with ether, I am persuaded that correct results are far harder to obtain than is ordinarily believed. Indeed, I regard these determinations, like those of water, as among the more difficult ones with which we have had to do.

ASH.

The ash was determined by charring about 2 grammes of the partly dried material, extracting the charred mass with water, burning the residue at a high temperature, adding the solution, evaporating and burning at a faint red heat. The charring and burning were conducted in platinum capsules over a gas flame. The crude ash thus obtained was practically free from coal. No determinations of carbonic acid were made.

PHOSPHORUS.

A portion of the partly dried substance, usually about 1 gramme, was carefully burned in a platinum crucible with some 10 grammes of a mixture of equal parts of sodium nitrate and carbonate, previously proved free from phosphoric acid. The white mass was dissolved in water, acidulated with nitric acid, evaporated and treated with nitric acid again, the operation being repeated when necessary to remove chlorine, and the phosphoric acid then estimated with ammonium molybdate solution.

A number of experiments were made to test the accuracy of the determinations in the presence of such large quantities of sodium nitrate, etc., as are necessarily used. They were carried out by Mr. G. P. Merrill, then assistant in this laboratory and now curator in the U. S. National Museum. It will suffice here to give the outcome, which was briefly this:

At the temperature of the trials, which was in each case not far from

29° C., two precautions are necessary: (1) the use of a large excess of the molybdate solution (unless nitric acid alone should perform the same office), and (2) allowance of ample time for precipitation. Neglect of these precautions involves risk of loss of phosphoric acid The effect of higher temperature was not tested. Practically, we have used 25 cc. of molybdate solution and allow from 36 to 48 hours for the precipitation.

SULPHUR.

About 1 gramme of the partly dried substance was oxidized as for the determination of phosphorus. The cooled mass was dissolved in hydrochloric acid, and the sulphuric acid determined by precipitation with barium chloride.

It is well known that the presence of salts of the alkalies, including sodium chloride, when present in considerable quantities, may affect the precipitation of sulphuric acid by barium chloride, the precipitate of barium sulphate bringing down with it under some circumstances more or less of the alkaline salt. The ordinary means for avoiding this consist in diluting the solution, precipitating hot, and washing the precipitate with hot water. In view of the large quantity of sodium chloride present in these determinations, it seemed desirable to study the conditions under which pure and impure barium sulphate precipitates are formed a little more closely than had, so far as I am aware, been done. For this purpose a series of experiments was devised. The details were faithfully carried out by Mr. J. P. Bartlett, then a student in this laboratory and now chemist in the Maine State College Agricultural Experiment Station.

The plan consisted in taking a solution of sulphuric acid and determining the amount of acid both in the solution alone and after adding different quantities of sodium chloride. Comparative trials were made with concentrated and dilute solutions and by precipitating hot and cold. The sulphuric-acid solution used was the same as employed for nitrogen determination with the soda lime. The sodium chloride solution contained about 25 per cent. of sodium chloride, and the barium chloride solution about 20 per cent. of the ordinary crystallized salt. Without going into details of the experiments, it will suffice to say that, although when precipitated cold from concentrated solutions the barium sulphate is apt to be too heavy, *i. e.*, to bring down sodium chloride, yet, when precipitated hot, or even precipitated cold from dilute solutions, it was uniformly pure. This is in accordance with the previous observations on which general practice is based. Our determinations served simply to show the limits of concentration and amount of sodium chloride within which it is safe to work. It should be noted, however, that the solutions contained in all cases a small amount of free hydrochloric acid, and that only a small excess of barium chloride was used in the precipitation. Practically, the ordinary way as recommended by Fresenius is accurate for these determinations, even in pres-

ence of large amounts of sodium chloride, provided the proper precautions are observed. The experiments satisfied us that the presence of the sodium chloride in the determinations of sulphur, as we conducted them, did not interfere with the accuracy of the results.

CHLORINE

was determined by burning the partly dried substance in platinum evaporating dishes, as in the determinations of phosphorus and sulphur, and estimating the chlorine in the fused mass with ammonium sulphocyanide by Volhard's process.* Dr. J. H. Long, then assistant in this laboratory, but now professor of chemistry in the Chicago Medical College, by whom the determinations were made, carried out, at my request, a series of experiments which led to the observance of certain precautions and showed that with them very satisfactory results may be obtained in the determination of chlorine in such substances as those we were working with. The precautions are contained in the following statement of the method followed in the determinations of chlorine in fish flesh.

(1) The substance was very slowly fused with a mixture of potassium nitrate and sodium carbonate so as to avoid any possible loss by spirting. It was observed that when the platinum capsule, in which the ignition was carried on, was covered with a watch glass, small portions of the substance were thrown out against it unless the operation was conducted very slowly. With care, however, there was no considerable loss, as indicated by either the appearance of the watch glass or actual determinations with sugar and a known amount of chlorine.

(2) The fused mass was dissolved in chemically pure nitric acid, which was made quite dilute, since by using a stronger acid some chlorine could easily be driven off, as was found by experiment.

(3) To the solution thus obtained an excess of silver nitrate solution (decinormal or half decinormal) was added, and the whole boiled on the water bath for about 2 hours. This long boiling with excess of nitric acid, added after the silver nitrate, was found necessary to expel nitrous acid coming from the reduction of the nitrate in the fusion.

(4) After the boiling, the solution was allowed to become quite cold before titrating.

As the details of the experiments on the determinations of phosphorus, sulphur, and chlorine are somewhat extended and will probably be printed in full in another place, they are not inserted here.

PROXIMATE INGREDIENTS DIRECTLY DETERMINED.

In a number of the specimens determinations were made of the ingredients soluble in cold and hot water, and of the portion not dissolved by water, alcohol, or ether. The object was as much to test the meth-

---

* Leibig's Annaler, 190, 1.

ods commonly employed as to learn the amounts of the ingredients. The methods have proved unsatisfactory in many respects, and we have felt it advisable to make no more determinations by them than are indicated in the tables until the subject is worked up more thoroughly. For that matter, a satisfactory examination of the proximate constituents will involve the study of a good deal more than the compounds of the flesh. Considering the complicated character of the compounds concerned, the vagueness of our present knowledge of them, and the amount of preliminary work necessary before such an investigation can be got into good running order; and adding to all this the importance of studying the elementary composition of the organic compounds, and the mineral ingredients as well, it is clear that much labor will be necessary to reach the desired results. Those we have obtained will at least serve to compare with similar ones obtained by other analysts.*

Cold-water extract.—Of the freshly chopped substance, $33\frac{1}{3}$ grammes were digested for 18 to 24 (generally about 20) hours in 500 cc. of cold water, and then filtered. The filtration was conducted at first through "coffee" filter paper, but we have found it better to use fine linen cloth, which has the advantages of more rapid filtration and of allowing the liquid to be squeezed through with proper care. The solids do not pass through the cloth more than through the filter paper, and by placing on a glass plate, scraping, and subsequent rinsing, they are separated much more easily and completely than they can be from the filter paper.

Albumen coagulated from cold-water extract.—The filtrate thus obtained was boiled and filtered through previously dried and weighed asbestos filters. After washing with ether, the filter with its contents was dried and weighed. That this method for determining albumen is accurate is by no means proven or even probable. Indeed, in some species of fish at least—and the same is true of other animals—the cold-water extract of the muscular tissues contains a form of albumen, or at any rate a substance or substances closely resembling albumen, which are not precipitated by boiling at all, except after the addition of large quantities of acid or salts. When the determinations in question were made, these substances had not been well studied, but I was persuaded that the method followed was not reliable for the determination of the actual amount of albumen, a view which studies, to be elsewhere discussed, have amply confirmed.

Extractive matters. Cold-water extract not coagulated by boiling.—The filtrate from the coagulated albumen was evaporated in platinum capsules and weighed. One portion was used for determination of the ash, which was done by charring at a low temperature, extracting with water, igniting the residue until it was well burned, adding the water solution, evaporating, igniting carefully at a low temperature, and weighing. The other portion was finely ground, dried in air to deter-

* See Almén. *Analyse des Fleisches einiger Fische,* Nova Acta Reg. Soc. Sc. Ups., Ser. III, Upsala, 1877.

mine the percentage of water, and extracted with ether until free from fat, usually 2 or 3 hours. The crude extract, minus the water, fat, and ash, is reckoned as pure extract, and is designated as "extractive matters." It of course contains the albumen which was not coagulated, the other nitrogenous compounds, the carbohydrates, and whatever else, except fats and mineral matters, was taken from the flesh of the fish by the digestion in cold distilled water.

Hot-water extract. "*Gelatin.*"—The residue left after the extraction with cold water was treated for 18 to 24 hours, generally about 20 hours, with distilled water at 100° or slightly below. It was then filtered through weighed asbestos filters, and the filtrate evaporated to dryness in platinum, and weighed as "crude gelatin." In this fat and ash were determined, and the pure extract, called in the tables "gelatin," estimated as in the cold-water extract. It should be stated that in both hot and cold water extracts the figures for total extract in the tables represent water-free substance, *i. e.*, crude extract minus water. I am inclined to think it would be better to determine both water and fat in the crude extracts in one operation by extracting with ether and noting the loss.

Insoluble protein.—The residue left after the extraction with hot water was treated with alcohol or ether, or both, dried, and weighed. Water, ash, and fat were then determined (except, of course, that fat was not determined in the cases where it had been previously extracted). The ash was determined by direct burning, it being assumed that the previous treatment with cold and hot water had sufficed to remove the easily fusible and volatile salts. The removal of the last portions of fat is often extremely difficult, and it is not impossible that in some cases traces were left and weighed as insoluble protein. The figures for total insoluble protein in the tables denote water-free substance.

It is perhaps superfluous to state that the determinations were all made in duplicate. The figures given in the tables which follow represent the averages of the closely agreeing results. The analytical details are given in the next chapter.

3. DESCRIPTIONS AND DETAILS OF ANALYSES OF SPECIMENS OF AMERICAN FISHES.

The usefulness of full statements of details of investigations of this sort is often insisted upon by chemists, and with justice. The attempt to properly collate and use results of other analyses of fish has impressed upon me anew and more strongly than ever the loss which such work often suffers from omission of details in reporting it.

The following data, regarding the analyses of fish and those of analyses of invertebrates, etc., beyond, have been compiled from our laboratory notebooks, the purpose being to make of them a faithful record of the facts regarding the specimens analyzed and the analytical results, and likewise to furnish such other data as, taken in connection

with the descriptions of the methods of analyses, would afford reasonably ample means for judging of the correctness of the other evidence upon which the numerical statements and conclusions in the succeeding chapters are based.

The explanations in the chapter on methods of analysis will, it is hoped, suffice to make the statements clearly understood.

In a number of the determinations of nitrogen, ether extract, etc., the percentages of water-free substance, "Wfr," in the partly dried substance, "Pd," are slightly different from those stated in the water determinations. This apparent discrepancy is explained by the fact that the determinations in question were made later, and, in some cases, in other portions of the material.

A number of the earlier analyses, made while the methods were being tested and before the routine was well in hand, were more or less unsatisfactory. Several were discarded entirely. Those here given seemed to me sufficiently accurate to warrant their insertion.

In the "direct determinations of proximate ingredients" the results are such as to make the sum of extractive matters + albumen + gelatin + insoluble protein, etc., in several cases considerably more or less than 100, which, of course, indicates errors in the figures. As stated in the descriptions of the methods, these analyses were so unsatisfactory as to deter us from further attempts until opportunity should be given for the experimental study needed to improve the methods. Meanwhile I have thought it proper to state the results exactly as we obtained them and thus give the reader the same opportunity that I have to judge how much they are worth. Where the footings varied more than 5 per cent. from 100 in the water-free substance of the flesh, the figures for "insoluble protein" and the footings are excluded from the tabularized statements beyond. The remaining analyses show in the figures for flesh (water plus water-free substance) no variations exceeding $1\frac{1}{4}$ per cent.; indeed all but two come within less than 1 per cent. of 100, which seems to be close enough to entitle them at least to preservation until more accurate results are obtained.

The arrangement of the specimens in this chapter in numerical order has seemed most convenient for reference.

NOTES ON SPECIMENS OF FISH.

The following notes are from laboratory books. The numbers are those used in the tables of analyses. Other data are summarized in Table 1. In cases where several specimens were weighed separately, and only the sums or averages are stated in that table, details are cited here.

1. Halibut. Purchased in Middletown. The specimen was a portion of the posterior half of the body. Price, 15 cents per pound.
2. Flounders. Purchased in Middletown. Price, 10 cents per pound.
3. Cod. Purchased in Middletown. Price, 15 cents per pound.

4. Eels (salt water). Purchased in Middletown. Eleven dressed fish, *i. e.*, with heads, entrails, and skin removed. Price, 10 cents per pound.

5. Alewife. Purchased in Middletown. Price, 12 cents per dozen. Twelve whole fish weighed 2,566 grammes (5 pounds 1.5 ounces). The cost per pound was thus 2½ cents.

6. Shad. Purchased in Middletown. Price, 20 cents per pound. Two whole fish.

7. Striped bass. Purchased in Middletown. One whole fish. Price, 20 cents per pound.

8. Mackerel. Purchased in Middletown. Four whole fish. Cost, 15 cents each.

9. Halibut. Purchased in Middletown. Sections of fatter portion of body. Price, 15 cents per pound.

10. Shad. Purchased in Middletown. One whole fish. Price, 8 cents per pound.

11. Cod. Purchased in Middletown. One fish with head and entrails removed. Price, 8 cents per pound.

12. Bluefish. Purchased in Middletown. One fish with entrails removed. Price, 10 cents per pound.

13. Mackerel. Purchased in Middletown. Two whole fish taken. Price, 18 cents per pound.

14. Salmon. Furnished by Mr. Blackford. Maine. One fish, entrails removed.

15. Porgy. Purchased in Middletown. Four whole fish.

16. Haddock. Purchased in Middletown. One fish, entrails removed. Price, 8 cents per pound.

17. Lake trout. Furnished by Mr. Blackford. Lake Ontario. Mr. Blackford described it as follows: "Salmon trout, *Cristivomer namaycush*, weighs 8 pounds 2 ounces. This is very plenty in the market at this season of the year. You will probably find spawn in it." The sample, a whole fish, weighed on receipt 7 pounds 15 ounces (3,600 grammes), and had evidently shrunk by loss of water and otherwise in coming. It had considerable spawn.

18. Whitefish. Furnished by Mr. Blackford. Lake Champlain. Mr. Blackford says: "White fish, *Coregonus clupeiformis*, weighs 2 pounds 15 ounces, caught at Alburgh Springs, Vermont, from Lake Champlain; is the great food-fish of the lakes and is in the finest condition at present season." The specimen consisted of one whole fish.

19. Striped bass. Furnished by Mr. Blackford. Bridgehampton, Long Island. Atlantic Ocean. Described by Mr. Blackford: "Striped bass, weighs 2 pounds 9 ounces, caught at Bridgehampton, Long Island, November 5, 1879. They are very plenty at this season and in their best condition." The specimen, one whole fish, weighed on receipt at Middletown 2 pounds 6.7 ounces, having evidently shrunk in transit.

20. Red snapper. Furnished by Mr. Blackford. Fernandina, Florida. One whole fish.

21. Haddock. Furnished by Mr. Blackford. Off Rockaway, Long Island. Atlantic Ocean. One fish with entrails removed.

22. Flounder. Furnished by Mr. Blackford. Amagansett, Long Island. Atlantic Ocean. The specimen, one whole fish, was rather old and the flesh very soft. It emitted some odor and looked "pasty" in drying. It is worthy of note in this connection that the percentage of "gelatin" was large.

23. Smelt. Furnished by Mr. Blackford. Hackensack River, New Jersey. Seventy-three whole fish.

24. Brook trout. Furnished by Mr. Blackford. "Cultivated trout." Six whole fish.

25. Boned codfish. Purchased April 8, 1880, in Middletown, Connecticut; in 5-pound packages; price 50 cents each, or 10 cents per pound. The following statements were printed on the box: "This package contains pure codfish, and that the best that can be cured. Great care is taken in the selection, curing, and packing,

and the fish is recommended to the consumer for its economy, convenience, cleanliness, and quality."

26. Red snapper. Furnished by Mr. Blackford. Eastern coast of Florida. One fish, entrails removed.

27. California salmon. Furnished by Mr. Blackford. Sacramento River, California. The specimen included only the edible portion of the anterior part of the body, and like No. 22 emitted some odor and in the drying swelled a great deal and became pasty.

28. Smoked halibut. Purchased in Middletown, Connecticut. Part of one side of fish, including skin and a few small bones.

29. Canned salmon. Purchased in Middletown. One can, said to contain 2 pounds; cost 45 cents. The sample had a good deal of oil. Flesh and oil were crushed together in a mortar; the oil was readily absorbed, so that the sample was easily worked. Weight of entire sample 870 grammes (1 pound 14.7 ounces) which would make actual cost of the contents of can about 23 cents per pound.

30. Mackerel. Furnished by Mr. Blackford. Off Cape May, New Jersey. Atlantic Ocean. Four whole fish.

31. Porgy. Furnished by Mr. Blackford. Rhode Island. Four whole fish.

32. Shad. Purchased in Middletown. Connecticut River. Price 10 cents per pound. One whole fish.

33. Smoked Herring. Purchased in Middletown. Six whole fish.

34. Salt codfish. Purchased in Middletown. Price 7 cents per pound. The specimen is of the kind known to the trade as "channel fish" and was said to have been caught in the deep water near George's Banks.

35 and 36. Spent (or foul) Salmon. Penobscot River, Maine. Four whole fish. Received November 18, 1880, from Government salmon-breeding establishment, through the courtesy of Mr. Charles G. Atkins, Bucksport, Maine. In an accompanying letter Mr. Atkins suggests that though "spent" salmon [the eggs having been removed by stripping] they were in better condition than those that have spawned naturally. From measurements made by Mr. H. L. Osborn, assistant in Natural History in Wesleyan University, I select the following as of interest in comparing the dimensions and weights of these with salmon in good condition: Nos. 35 *a* and 35 *b* were males; Nos. 36 *a* and *b*, females; portions of Nos. 35 *a* and *b* were sampled together and analyzed as No. 35. The same was done with Nos. 36 *a* and *b*, which were analyzed as No. 36.

Nos.	Greatest height of body.	Greatest width of body.	Least height of body.	Girth at tip of pectoral fin.	Girth at anterior end of dorsal.	Girth over anus.	Girth at posterior end of adipose fin.	Length to tip of middle caudal ray.	Length to base of middle caudal ray.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
35*a*	156	60	58	360	380	290	200	826	750
35*b*	154	58	57	355	365	285	190	830	750
36*a*	163	63	66	380	390	340	200	915	835
36*b*	166	64	67	400	395	315	210	896	813

37. Salt codfish. Purchased in Middletown. Near Nantucket. Atlantic Ocean. The fish is of the kind known as "boatfish" and was said to have been caught near the shore off Nantucket.

38. Blackfish. Furnished by Mr. Blackford. Stonington, Connecticut. Atlantic Ocean. Five whole fish.

39. Mackerel. Furnished by Mr. Blackford. Cape Cod. Atlantic Ocean. One whole fish.

40 and 41. Spent landlocked salmon. Eight whole fish. From Schoodic Salmon-breeding Establishment, Grand Lake Stream, Maine. Sample received from Charles

G. Atkins, who says, in letter dated Grand Lake Stream, Maine, November 27, 1880, "I send * * * four male land-locked salmon and four females, whose eggs have been taken from them by the artificial process. They are as near spent fish as we can get, but I think they are in better condition than those that have spawned naturally." The following measurements and weights indicate the size of the fish and proportions of flesh and refuse:

Nos.	Greatest length.	Girth at tip of pectoral fin.	Girth at anterior base of dorsal fin.	Girth at anus.	Edible portion.	Waste, entrails, etc.	Loss in cleaning.	Total weight.	Total weight in pounds and ounces.
	mm.	*mm.*	*mm.*	*mm.*	*Grms.*	*Grms.*	*Grms.*	*Grms.*	*Lbs. Oz.*
40*a*	520	285	292	216	745.1	767.5	17.4	1,530.0	3 5.9
40*b*	500	250	255	175	623.8	594.8	11.6	1,230.2	2 11.4
40*c*	510	265	278	220	754.3	741.9	10.4	1,506.6	3 5.1
40*d*	500	260	270	195	761.8	648.8	8.9	1,419.5	3 2.
41*a*	480	230	240	177	562.1	471.3	19.6	1,053.0	2 5.1
41*b*	460	220	225	175	494.7	401.7	6.7	903.1	1 15.8
41*c*	450	220	210	168	402.1	391.1	9.3	802.5	1 12.3
41*d*	450	210	200	160	442.9	409.4	11.4	863.7	1 14.5

Nos. 40*a*, 40*b*, 40*c*, 40*d*, were sampled together and analyzed as No. 40. The same was done with 41 *a*, *b*, *c*, and *d*, which were analyzed as 41.

42. Salt mackerel. Purchased in Middletown. The specimen was described as "No. 1 mackerel." Caught probably in September or October, as the barrel from which the sample was taken was marked as inspected at Chatham, Massachusetts, in October. Price, 12½ cents per pound.

43. Spanish mackerel. Furnished by Mr. Blackford. One whole fish.

44. White perch. Furnished by Mr. Blackford. Two whole fish, both of which were quite full of spawn.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Total.
	Grms.	*Grms.*	*Grms.*
Flesh	128.7	142.7	271.4
Refuse..............	208.0	279.0	487.0
Loss	6.7	5.0	11.7
Total	343.4	426.7	770.1

45. Muskellunge. Furnished by Mr. Blackford. St. Lawrence River. Mr. Blackford says: "It is not often found in our markets." One whole fish taken for analysis.

46. White perch. Furnished by Mr. Blackford. Four whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	*c.*	*d.*	Total.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	78.7	110.6	78.0	71.9	339.2
Refuse..............	129.2	196.5	127.2	125.5	578.4
Loss	7.1	4.6	3.3	3.3	18.3
Total	215.0	311.7	208.5	200.7	935.9

47. Herring. Furnished by Mr. Blackford. Four whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	*c.*	*d.*	Total.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	136.5	163.0	121.5	131.5	552.5
Refuse	142.0	129.0	83.0	143.2	497.2
Loss	5.9	10.2	5.5	9.5	31.1
Total	284.4	302.2	210.0	284.2	1,080.8

48. Sheepshead. Furnished by Mr. Blackford. Florida. One fish, entrails removed.

49. Turbot or Greenland halibut. Furnished by Mr. Blackford. Newfoundland One whole fish. The fish had been frozen and partly thawed.

52. Yellow pike perch or wall-eyed pike. Furnished by Mr. Blackford. Two whole fish, of which the heavier had considerable immature spawn.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Total.
	Grms.	*Grms.*	*Grms.*
Flesh	232.5	230.2	462.7
Refuse	369.2	273.5	642.7
Loss	9.8	7.5	17.3
Total	611.5	511.2	1,122.7

53. Black bass (large-mouthed black bass). Furnished by Mr. Blackford. One whole fish.

77 and 78. Salmon. Samples received from Mr. Atkins. Penobscot River, Maine. The specimen consisted of two females, whole fish, which were analyzed separately as Nos. 77 and 78. Mr. Atkins writes: "The two females, weighing 24 pounds, are in good condition, well fed and fat, though a little inferior to what might have been obtained in May or early in June. The salmon season is about closed and fish are scarce."

79. Desiccated cod. From Mr. A. R. Crittenden, Middletown, Connecticut. The specimen, called "Alden's Fresh Codfish" was a finely pulverized, yellowish-white material, of agreeable odor and attractive appearance. It was stated to be prepared by a process invented by Mr. Alden, of Gloucester, Massachusetts, well known for his connection with the invention of the process of manufacturing condensed milk. The commercial enterprise has, I am informed (October, 1881), since been transferred to the Hurricane Isle Fish Company, Rockland, Maine, which is now preparing the product under the name of "Evaporated Fish." Their process of manufacture is described in one of their circulars as follows: "The fresh fish are brought in daily as caught, to the island, which is 12 miles out at sea. They are at once dressed, while perfectly fresh, and the pure flesh put into a large open evaporating pan with a steam jacket. This pan is provided with steam machinery, which keeps the flesh in constant motion until it is sufficiently dried. During the process one-half pound of common salt is added to each 100 pounds of pure flesh, not, however, for the purpose of preserving the product, but simply to improve the flavor; more salt will be required while cooking. At no time is the heat in the pan allowed to reach that of boiling water. No destructive distillation takes place and nothing but water is removed from the fish. After removing the product from the evaporating pan it is sifted to remove any bones which may have accidentally been left in the flesh."

80. Desiccated cod—"Alden's Salt Cod-fish." Received from Mr. A. R. Crittenden, Middletown, Connecticut. This is said to be similar to No. 79, except that more

salt was added before drying. I infer that it is not prepared in this way to any great extent commercially.

81. Pollock. Furnished by Mr. Blackford. Coast of Massachusetts. Atlantic Ocean. One fish, head and entrails removed.

87. Sardines. Purchased in Middletown. One half-box containing 15 sardines said to have been packed in France. The oil was separated by draining, but in the preparation of the material for analysis as well as in the actual analysis it was, of course, impossible to accurately separate the oil belonging to the flesh from that in which they were packed.

88. Smoked haddock or "Findon haddie." Purchased in Middletown. One smoked haddock (3½ pounds), head and entrails removed. Price 12 cents per pound.

90. Butter-fish. Furnished by Mr. Blackford. East end of Long Island. Atlantic Ocean. Four whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	*c.*	*d.*	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	136.5	86.3	92.0	90.2	101.1
Refuse	101.0	65.0	72.0	71.0	77.4
Loss	3.0	2.7	2.2	2.0	2.5
Total	240.5	154.0	166.2	163.2	181.0

91. Black Bass (small-mouthed black bass). Furnished by Mr. Blackford. Seneca Lake, New York. Two whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	231.5	119.0	175.2
Refuse	267.5	147.3	207.4
Loss	5.0	2.5	3.8
Total	504.0	268.8	386.4

94. Canned fresh mackerel. Purchased in Middletown. The analysis was made of the total can contents, which weighed 468.5 grammes (1 pound 0.5 ounce) and contained some bone, which was, however, "perfectly soft and edible."

95. Salt mackerel. Purchased in Middletown. One 5-pound can labeled "Ocean Gem Mackerel." The can was marked as inspected "Gloucester, Mass., Mackerel, No. 2, 5 lbs. 1880." The fish were in the condition in which salt mackerel are ordinarily sold, except that the heads and tails were removed. Two fish were analyzed as follows:

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	183	195	189
Refuse	38	40	39
Loss	2	2	2
Total	223	237	230

96. Canned Salmon. Purchased in Middletown. Columbia River, Oregon. One pound can. Price 20 cents. The contents weighed 474 grammes (1 pound 0.7 ounces).

98. Pickerel. Furnished by Mr. Blackford. Lake Ontario. One fish, entrails removed but containing spawn.

99. Tomcod. Furnished by Mr. Blackford. South side Long Island, New York. Atlantic Ocean. Four whole fish, females, with spawn.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	*c.*	*d.*	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	120.5	128.5	112.5	80.5	110.5
Refuse	182.0	188.5	164.0	143.0	169.4
Loss	4.5	3.0	1.5	3.2	3.0
Total	307.0	320.0	278.0	226.7	282.9

100. Pickerel. Furnished by Mr. Blackford. Seneca Lake, New York. Three whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	*c.*	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*
Flesh	163.0	174.5	173.0	170.2
Refuse	127.5	174.5	134.5	145.5
Loss	5.9	4.5	3.2	4.5
Total	296.4	353.5	310.7	320.2

110. Cusk or torsk. Furnished by Mr. Blackford. Atlantic Ocean. One fish, entrails removed.

111. Cisco or lake herring. Furnished by Mr. Blackford. Lake Erie. Four whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	*c.*	*d.*	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	158.0	206.0	172.5	166.5	175.7
Refuse	110.5	154.5	150.5	121.0	134.1
Loss	3.0	5.5	5.0	3.5	4.2
Total	271.5	366.0	328.0	291.0	314.0

113. Hake. Furnished by Mr. Blackford. Off Long Island, New York. Atlantic Ocean. One fish, entrails removed.

114. Grouper. Furnished by Mr. Blackford. From Gulf of Mexico near Pensacola, Florida. One fish, entrails removed.

126. Mullet. Furnished by Mr. Blackford. Virginia. One whole fish.

127. Yellow perch. Furnished by Mr. Blackford. Lake Champlain. Four whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	*c.*	*d.*	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	89.0	118.0	116.0	98.0	105.3
Refuse	148.0	205.0	230.0	139.0	180.5
Loss	2.0	2.5	3.5	1.0	2.2
Total	239.0	325.5	349.5	238.0	288.0

205. Blackfish. Purchased in Middletown. One whole fish. Price, 12 cents per pound.

206. Rock cod. Purchased in Middletown. Eight miles southeast of Block Island, Atlantic Ocean. One whole fish, 4 pounds. Price, 10 cents per pound.

207. Smelt. Purchased in Middletown. Coast of Maine. Fourteen whole fish weighed 398 grammes (14 ounces).

208. Yellow perch. Purchased in Middletown. Portland, Connecticut. Six dressed fish, head, entrails, fins, and tails removed, weighed 302 grammes, averaging 50.3 grammes (1.8 ounces). Price, 15 cents per pound.

211. Halibut. Purchased in Middletown. George's Banks, Atlantic Ocean. Four slices weighing 8½ pounds from different parts of a fish which weighed dressed 17 pounds. The four pieces were selected to represent the average composition of the whole fish. Price, 20 cents per pound.

212. Shad. Purchased in Middletown. Delaware River. One whole fish. Price, 70 cents each.

217. Eels, salt-water. Purchased in Middletown. Northern coast of Long Island. Atlantic Ocean. Six fish, head, skin, and entrails removed, weighed 436 grammes, average 72.7 grammes (2.6 ounces). Price, 12½ cents.

218. Smoked halibut. Purchased in Middletown. Price, 18 cents per pound.

219. Canned salt mackerel. Furnished by H. B. & F. K. Thurber & Co., New York City. Twelve fishes in can, weighing 2,219 grammes (4 pounds 14.5 ounces). Head and tails removed. Two taken for analysis.

220. Alewife. Purchased in Middletown. Connecticut River. Four whole fish. Price, 12 cents per dozen.

221. Shad. Purchased in Middletown. Connecticut River. One whole fish, caught April 17. The first shad of the season were taken April 14. Price 20 cents per pound.

224. Pickerel. Purchased in Middletown. Connecticut River, East Haddam. Two whole fish. Price 12 cents per pound.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	144.0	145.0	144.5
Refuse	151.0	141.0	146.0
Loss	9.0	11.0	9.5
Total	304.0	297.0	300.0

225. Striped bass. Purchased in Middletown. Long Island Sound. One whole fish, weighing 2½ pounds. Price 20 cents per pound.

228. Cod. Purchased in Middletown. One fish, head and entrails removed. Price 10 cents per pound.

229. Haddock. Purchased in Middletown. One fish, entrails removed. Price 8 cents per pound.

230. Mackerel. Purchased in Middletown. Two fish, entrails removed but spawn left in. Price 15 cents each.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	201.0	166.0	183.5
Refuse	130.2	130.0	130.1
Loss	9.3	3.5	6.4
Total	340.5	299.5	320.0

233. California salmon. Furnished by Mr. Blackford. Sacramento, California. Sections of anterior portion of body.

234. Pompano. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One whole fish.

236. Lamprey eel. Furnished by Mr. Blackford. Hackensack River, New Jersey. Two whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	202.0	450.5	326.3
Refuse	196.0	397.0	296.5
Loss	21.5	28.0	24.7
Total	419.5	875.5	647.5

237. Striped bass. Furnished by Mr. Blackford. North Carolina. One whole fish.

238. Sturgeon. Furnished by Mr. Blackford. Delaware River. Sections of anterior portion of body.

240. Canned tunny. Furnished by H. B. & F. K. Thurber & Co., New York City. One can "Tunny fish." The contents weighed 361.5 grammes (12.8 ounces).

241. Canned salmon. One-pound can "Columbia River Salmon." The contents of the can weighed 470 grammes (1 pound 0.6 ounces).

242. Red snapper. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One fish, entrails, gills, etc., removed.

243. Cod. Furnished by Mr. Blackford. Long Island, Atlantic Ocean. One whole fish, weighing in New York 5½ pounds.

244. Blackfish. Furnished by Mr. Blackford. Massachusetts coast, Atlantic Ocean. One fish, entrails removed.

245. Shad. Furnished by Mr. Blackford. Hudson River. One whole shad (3½ pounds).

246. Shad roe from shad No. 245.

247. Skate. Furnished by Mr. Blackford. Long Island. Atlantic Ocean. Left lobe of body.

248. Striped bass. Furnished by Mr. Blackford. Long Island. Atlantic Ocean. One whole fish.

249. Shad. Furnished by Mr. Blackford. North Carolina. One whole fish.

250. Sheepshead. Furnished by Mr. Blackford. One whole fish.

251. Sea bass. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One whole fish. Mr. Blackford says: "6½-pound grouper."

252. Kingfish. Furnished by Mr. Blackford. North Carolina. One whole fish.

253. Flounder. Furnished by Mr. Blackford. Rhode Island. Atlantic Ocean. One whole fish.

254. Brook trout, cultivated. Furnished by Mr. Blackford. South Side Club, Long Island. Three whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	*c.*	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*
Flesh	63.0	64.0	53.5	60.2
Refuse	58.0	55.0	46.5	53.2
Loss	4.5	4.5	4.0	4.3
Total	125.5	123.5	104.0	117.7

255. Lake or Mackinaw trout. Furnished by Mr. Blackford. Lake Ontario. One fish (frozen when shipped, thawed before arrival), entrails removed.

256. Canada trout. Furnished by Mr. Blackford. Montreal, Canada. One whole fish.

257. Gray or pike perch. Furnished by Mr. Blackford. Cleveland, Ohio. (Lake Erie?) One whole fish.

258. Small-mouthed red-horse. Furnished by Mr. Blackford. Cleveland, Ohio. One fish, entrails removed. The specimen was called by Mr. Blackford "buffalo fish," but had the characters of *Moxostoma* rather than *Ichthyobus*, to which latter genus the buffalo fishes properly belong. The two are, I understand, very similar, so that the common names may very naturally be interchanged.

259. Haddock. Furnished by Mr. Blackford. Long Island. One fish, entrails removed.

260. Striped bass. Furnished by Mr. Blackford. Long Island. Atlantic Ocean. One fish, entrails removed.

261. Mackerel. Furnished by Mr. Blackford. Capes of Virginia. Atlantic Ocean. One whole fish.

262. Porgy or scuppaug. Furnished by Mr. Blackford. One whole fish.

263. Pompano. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One whole fish.

269. Blackfish. Furnished by Mr. Blackford. Rhode Island. Atlantic Ocean. One fish, entrails removed.

270. Red bass. Furnished by Mr. Blackford. North Carolina. One whole fish. Flesh of one side used for analysis.

271. Red grouper. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One fish, entrails removed. Flesh of one side used for analysis.

273. Weakfish. Furnished by Mr. Blackford. Long Island, Atlantic Ocean. Two whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	252.5	175.0	213.7
Refuse	272.0	200.0	236.0
Loss	5.5	4.5	5.0
Total	530.0	379.5	454.7

275. Canned smoked haddock, "Findon Haddie." Furnished by H. B. & F. K. Thurber & Co., New York City. One pound can. The analysis was made of the total contents of the can which, as the gentleman who made the analysis states, "seemed to have been so treated as to soften the hard parts." The weight of the contents was 480.0 grammes (1 pound 1 ounce).

279. Salmon, female. Furnished by C. G. Atkins. Penobscot River, Maine. One whole fish.

280. Salmon, male. Furnished by C. G. Atkins. Penobscot River, Maine. One whole fish.

DETAILS OF ANALYSES OF FLESH OF FISH.

Herewith are full details of analyses of four specimens of flesh of fish transcribed from our laboratory books. They will serve to show what determinations were made and how they were recorded and the calculations made from them. Following them are summaries in tabular form of the determinations of all the specimens.

The details of the analyses of the proximate ingredients as directly determined are somewhat complicated, as may be seen from the illustrations given. The results are at best unsatisfactory, and it is not deemed desirable to tabulate the details in full.

Laboratory Number 20.

Name: Red snapper, *Lutjanus blackfordi.*
Locality: Fernandina, Florida.
Received: November 28, 1879, from Mr. Blackford.
Description: One whole fish.

Weighings in preparation for analysis.

	Grms.	*Lb.*	*Oz.*	*Per cent.*
Flesh	2, 104. 6	4	10. 2	60.00
Refuse	1, 388. 9	3	1. 0	39. 60
Loss	14. 0	....	0. 5	0. 40
Total	3, 507. 5	7	11. 7	100. 00

Analysis of flesh.

Water, (Dried in hydrogen).
Partial drying.—95.5 grm. fresh substance, "Fr." = 22.5 grm. partially dried, "Pd." = 23.56 % Pd. in Fr.
Complete drying.—1.1473 grm. Pd. = 1.1053 grm. Water-free, "Wfr." = 96.34 % Wfr. in Pd.
Complete drying.—1.1565 grm. Pd. = 1.0245 grm. Water-free, "Wfr." = 88.56 % Wfr. in Pd.
Av'ge 92.45 % Wfr. in Pd.
23.56 % Pd. in Fr. × 92.45 % Wfr. in Pd. = 21.78 % Wfr. in Fr., or 78.22 % Water in Fr.

Nitrogen. 0.4792 grm. Pd. = 0.4430 grm. Wfr., gave 0.06574 grm. N. = 14.84 % N.
0.4829 = 0.4465 0.06622 = 14.80
Av'ge 14.82 % N. in Wfr. or 3.23% N. in Fr.

Ether Ext. 0.9960 grm. Pd. = 0.9210 grm. Wfr., gave 0.0265 grm. Ext. = 2.87 % Ext.
0.9995 = 0.9243 0.0261 = 2.83 %
Av. 2.85 % Ext. in Wfr. or 0.62 % Ext. in Fr.

Ash. 3.073 grm. Pd. = 3.056 grm. Wfr., gave 0.178 grm. Ash = 5. 82 % Ash in Wfr. or 1. 27 % Ash in Fr.

P_2O_5. 1.0187 grm. Pd. = 0.9418 grm. Wfr., gave 0.0200 grm. P_2O_5 = 2.13 % P_2O_5
1.0910 = 1.0085 0.0219 = 2.17
Av'ge 2.15 % P_2O_5 in Wfr. or 0.47 % P_2O_5 in Fr.

SO_3. 1.000 grm. Pd. = 0.8936 grm. Wfr., = 0.0192 grm. SO_3 = 2.15 % SO_3
1.0015 = 0.8949 = 0.0199 = 2.22
Av'ge 2.19 % SO_3 in Wfr. or 0.47 % SO_3 in Fr.

Albumen in cold-water Ext. 33.3 grm. Fr. = 7.26 grm. Wfr., gave 0.5305 grm. Alb. = 7.30 % Alb.
33.3 = 7.26 0.5310 = 7.31 %
Av'ge 7.30 % Alb in Wfr. or 1.59 % Alb. in Fr.

Extractives, etc., in cold-water Ext. 33.3 grm. Fr. = 7.26 grm. Wfr., gave 0.8855 grm. Ext. containing 0.267 grm. ash = 0.6185 grm. water and ash-free Ext. = 8.52 % Ext. in Wfr.

33.3 grm. Fr. = 7. 26 grm. Wfr. gave 0.841 grm. Ext. containing 0.242 grm. ash. = 0.599 grm. water and ash-free Ext. = 8.25 % Ext. in Wfr. Av'ge 8.38 % Ext. in Wfr. or 1.81 % Ext. in Fr.

Gelatin in hot-water Ext. 33.3 grm. Fr. = 7. 26 grm. Wfr., gave 1.265 grm. crude gel. containing 0.056 grm. ash = 1. 209 grm. water and ash-free gel. = 16.65 % gel. in Wfr.

33.3 grm. Fr. = 7.26 grm. Wfr., gave 1.278 grm. crude gel. containing 0.056 grm. ash = 1.222 grm. water and ash free gel. = 16.83 % gel. in Wfr. Av'ge 16.74 % gel. in Wfr. or 3. 65 % gel. in Fr.

Insoluble protein. 33.3 grm. Fr. = 7.26 grm. Wfr., gave 4.555 grm. crude insoluble protein ("Ins.") = 62.74 % crude Ins. in Wfr. 33.3 grm. Fr. = 7.26 grm. Wfr. gave 4.279 grm. crude Ins. = 58.94 % crude Ins. in Wfr. Av'ge 60.84 % crude Ins. in Wfr. or 13.25 Ins. in Fr.

Recapitulation of analysis of flesh.

Constituents.	Protein = N × 6. 25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	....	78. 22	....	78. 22
Protein	92. 63	20. 17	91. 33	19. 89
Ether extract	2. 85	0. 62	2. 85	0. 62
Ash	5. 82	1. 27	5. 82	1. 27
Total	101. 30	100. 28	100. 00	100. 00

Proximate ingredients directly determined.

Constituents.	In water-free substance.	In fresh substance.	In fresh substance calculated to 100 p. ct.
Water		78.22	78.22
Albumen coagulated from cold-water extract	7.30	1.59	1.55
Extractives, etc., not coagulated in cold-water extract	8.38	1.81	1.81
Gelatin, hot-water extract	16.83	3.65	3.65
Insoluble protein	60.84	13.25	12.88
Ether extract	2.85	0.62	0.62
Ash	5.82	1.27	1.27
Total	102.02*	100.41*	100.00

LABORATORY NUMBER 52.

Name: Yellow pike perch or wall-eyed pike. *Stizostedion vitreum.*
Received: March 17, 1881, from Mr. Blackford.
Description: Two whole fish, of which the heavier had considerable immature spawn.

Weighings in preparation for analysis.

Constituents.	a.	b.	Total.			
	Grms.	*Grms.*	*Grms.*	*Lb.*	*Oz.*	*Per cent.*
Flesh	232.5	230.2	462.7	1	0.3	41.21
Refuse	369.2	273.5	642.7	1	6.6	57.25
Loss	9.8	7.5	17.3	...	0.6	1.54
Total	611.5	511.2	1,122.7		2.75	100.00

Analysis of flesh.

Water, (Dried in hydrogen).
Partial drying.—61.9 grm. fresh substance, "Fr." = 13.1 grm. partially dried, "Pd," = 21.16% Pd. in Fr.
Complete drying.—1.0675 grm. Pd. = 1.0215 grm. Water-free, "Wfr." = 95.69% Wfr. in Pd.
Complete drying.—1.0565 grm. Pd. = 1.0120 grm. Water-free, "Wrf." = 95.79% Wrf. in Pd.
Av'ge 95.74% Wfr. in Pd.
21.16% Pd. in Fr. × 95.74% Wfr. in Pd. = 20.26% Wfr. in Fr., or 79.74% Water in Fr.

Nitrogen. 0.6005 grm. Pd. = 0.5748 grm. Wfr. gave 0.08432 grm. N. = 14.67% N.
0.5995 = 0.5739 0.08413 = 14.66
Av'ge 14.67% N. in Wfr. or 2.97% N. in Fr.

Ether Ext. 0.700 grm. Pd. = 0.6703 grm. Wfr., gave 0.0195 grm. Ext. = 2.31% Ext.
0.704 grm. Pd. = 0.6706 grm. Wfr., gave 0 0195 grm. Ext. = 2.31% Ext.
Av. 2.31% ext. in Wfr. or 0.47% ext. in Fr.

Ash. 3.010 grm. Pd. = 2.954 grm. Wfr., gave 0.1995 grm. Ash = 6.75% Ash
Av'ge 6.75% Ash. in Wfr. or 1.37% Ash in Fr.

P_2O_5 0.9070 grm. Pd. = 0.8902 grm. Wfr., gave 0.0202 grm. P_2O_5 = 2.26% P_2O_5
0.9015 = 0.8848 0.0195 = 2.21
Av'ge 2.24% P_2O_5 in Wfr. or 0.45% P_2O_5 in Fr.

SO_3 0.9030 grm. Pd. = 0.8863 grm. Wfr., gives 0.0388 grm. SO_3 = 4.38% SO_3
0.9035 = 0.8868 0.0394 4.48
Av'ge 4.43% SO_3 in Wfr. or 0.90% SO_3 in Fr.

Albumen in cold-water Ext.
33.3 grm. Fr. = 6.7533 grm. Wfr., gives 0.4045 grm. Alb. = 1.21% Alb.
33.3 = 6.7533 0.3885 = 1.16%
Av'ge 1.19% Alb. in Fr. or 5.87% Alb. in Wfr.

Extractives, etc., in cold-water Ext.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 1.2365 grm. crude Ext. = 3.70% cr. Ext.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 1.2420 grm. crude Ext. = 3.73% cr. Ext.
Av'ge 3.72% cr. Ext. in Fr. or 18.36% cr. Ext. in Wfr.
0.4085 grm. crude Ext. gave 0.0105 grm. water = 2.57% water
0.4085 0.0065 fat = 1.63 fat
0 9280 0.2190 Ash = 24.22 Ash
28.42% = 71.58% pure Ext. in crude Ext.
18.36% crude Ext. = 13.14% pure Ext. in Wfr. = 2.66% pure Ext. in Fr.

Gelatin in hot-water Ext.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 1.2340 grm. crude gel. = 3.70% crude gel.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 1.2570 grm. crude gel. = 3.77% crude gel.
Av'ge 3.74% crude gel. in Fr. or 18.46% crude gel. in Wfr.
0.9935 grm. crude gel. gave 0.0170 grm. water = 1.71% water
0.9935 0.0045 fat 0.46 fat
1.2340 0.0710 Ash = 5.85 Ash
8.02% = 91.98% pure gel. in crude gel.
18.46% crude gel. = 16.98% pure gel. in Wfr. 3.44% pure gel. in Fr.

---

* The excess above 100 is doubtless due in part at least to the ash of the albumen and insoluble protein from which the ash was not subtracted. The composition of the fresh substance is recalculated to 100 by subtracting this excess from the insoluble protein and albumen.

Insoluble protein.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 3.6755 grm. crude Ins. = 11.03% crude Ins.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 3.6700 grm. crude Ins. = 11.01% crude Ins.
} Av'ge 11.02% crude Ins. in Fr. or 54.39% crude Ins. in Wfr.
0.9245 grm. crude Ins. gave 0.0085 grm. water = 0.92% water
0.9245 0.0185 fat = 2.02 fat
3.2720 0.0380 Ash = 1.17 Ash
} 4.11% = 95.89% pure Ins. in crude Ins.
54.39% crude Ins. = 52.15% pure Ins. in Wfr. = 10.57% pure Ins. in Fr.

Recapitulation of the analysis of flesh.

Constituents.	Protein = N × 6.25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	....	79.74	....	79.74
Protein	91.69	18.58	90.94	18.42
Ether extract	2.31	0.47	2.31	0.47
Ash	6.75	1.37	6.75	1.37
Total	100.75	100.16	100.00	100.00

Proximate ingredients directly determined.

Constituents.	In water-free substance.	In fresh substance.	In fresh substance, calculated to 100 pr. ct.
	Per cent.	*Per cent.*	*Per cent.*
Water	....	79.74	80.19
Albumen coagulated in cold-water extract	5.87	1.19	1.19
Extractives, etc., not coagulated in cold-water extract	13.14	2.66	2.68
Gelatin in hot-water extract	16.98	3.44	3.46
Insoluble protein	52.15	10.57	10.63
Ether extract	2.31	0.47	0.47
Ash	6.75	1.37	1.38
Total	97.20	99.44	100.00

LABORATORY NUMBER 247.

Name: Skate, *Raia* sp.?
Locality: Long Island, Atlantic Ocean.
Received: April 26, 1882, from Mr. E. G. Blackford.
Description: Left lobe of body.

Weighings in preparation for analysis.

	Grms.	*Lb.*	*Oz.*	*Pr. ct.*
Flesh	996.0	2	3.2	46.32
Refuse	1,097.0	2	6.7	51.03
Loss	57.0		2.0	2.65
Total	2,150.0	4	11.9	100.00

Analysis of flesh.

Water (dried in hydrogen).
Partial drying.—100.00 grms. fresh substance, "Fr." = 20.99 grms. partially dried "Pd." = 20.99 % Pd. in Fr.
Complete drying.—1.0000 grm. Pd. = 0.8503 grm. Water-free, "Wfr." = 85.03 % Wfr. in Pd.
Complete drying.—0.9997 grm. Pd. = 0.8497 grm. Water-free, "Wfr." = 85.00 % Wfr. in Pd.
*Complete drying.—1.0000 grm. Pd. = 0.504 grm. Water-free, "Wfr." = 85.04 % Wfr. in Pd.
} Av'ge 85.02 % Wfr. in Pd.
20.99 % Pd. in Fr. × 85.02 % Wfr. in Pd. = 17.85 % Wfr. in Fr., or 82.15 % Water in Fr.

Nitrogen. 0.6000 grm. Pd. = 0.5101 grm. Wfr., gave 0.08301 grm. N. = 16.28 % N.
0.6000 = 0.5101 0.08313 16.29
*0.6000 = 0.5101 0.08316 16.30
} Av'ge 16.29 % N. Wrf. or 2.91 % N. in Fr.

Ether ext. 0.5000 grm. Pd. = 0.4251 grm. Wfr., gave 0.0332 grm. Ext. = 7.81 % Ext. } Av'ge 7.81 % Ext. in Wfr. or 1.39 % Ext. in Fr.
0.5000 = 0.4251 0.0332 = 7.81 %

Ash. 2.0000 grm. Pd. = 1.7004 grm. Wfr., gave 0.1079 grm. Ash. = 6.35 % Ash } Av'ge 6.38 % Ash in Wfr. or 1.14 % Ash in Fr.
2.0000 = 1.7004 0.1090 = 6.41 %

Recapitulation of analysis of flesh.

Constituents.	Protein = N × 6.25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	....	82.15	....	82.15
Protein	101.82	18.17	85.81	15.32
Ether extract	7.81	1.39	7.81	1.39
Ash	6.38	1.14	6.38	1.14
Total	116.01	102.85	100.00	100.00

*The percentage of nitrogen found in the regular analysis was so large that these triplicate determinations were made later to confirm the results.

Laboratory Number 261.

Name: Mackerel, *Scomber scombrus.*
Locality: Capes of Virginia, Atlantic Ocean.
Received: Apr. 29, 1884, from Mr. E. G. Blackford.
Description: One whole fish.

Weighings in preparation for analysis.

	Grms.	*Ounces.*	*Per ct.*
Flesh	279.0	9.8	48.43
Refuse	290.0	10.3	50.35
Loss	7.0	0.3	1.22
Total	576.0	1 lb. 4.4	100.00

Analysis of flesh.

Water (dried in hydrogen).
Partial drying.—100.00 grms. fresh substance, "Fr." = 26.05 grms. partially dried, "Pd." = 26.05 % Pd. in Fr.
Complete drying.—0.9997 grm. Pd. = 0.9425 grm. Water-free, "Wfr." = 94.28 % Wfr. in Pd.
Complete drying.—1.0002 grm. Pd. = 0.9430 grm. Water-free, "Wfr." = 94.28 % Wfr. in Pd. } Av'ge 94.28 % Wfr. in Pd.
26.05 % Pd. in Fr. × 94.28 % Wfr. in Pd. = 24.56 % Wfr. in Fr., or 75.44 % Water in Fr.

Nitrogen. 0.6000 grm. Pd. = 0.5658 grm. Wfr., gave 0.07164 grm. N. = 12.66 % N. } Av'ge 12.66 % N. in Wfr. or 3.11 % N. in Fr.
0.6000 = 0.5658 0.07179 = 12.67 %

Ether ext. 0.5000 grm. Pd. = 0.4714 grm. Wfr., gave 0.0808 grm. Ext. = 17.14 % Ext. } Av'ge 17.13 % Ext. in Wfr. or 4.21 % Ext. in Fr.
0.5000 = 0.4714 0.0807 = 17.12 %

Ash. 2.0000 grm. Pd. = 1.8856 grm. Wfr., gave 0.0990 grm. Ash = 5.25 % Ash } Av'ge 5.23 % Ash. in Wfr. or 1.28 % Ash. in Fr.
2.0000 = 1.8856 0.0980 = 5.20 %

Recapitulation of analysis of flesh.

Constituents.	Protein = N × 6.25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	....	75.44	....	75.44
Protein	79.10	19.43	77.64	19.07
Ether extract	17.13	4.21	17.13	4.21
Ash	5.23	1.28	5.23	1.28
Total	101.46	100.36	100.00	100.00

Details of analyses of flesh of specimens of fish.

[Determinations of water, nitrogen, ether extract (fat), and ash.]

Laboratory No. of specimen.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
1	23.70	87.91 88.04	87.98	13.46 13.45	13.46	10.59 10.58	10.59	5.53	5.53
2	17.56	94.79 94.61	94.70	14.35 14.34	14.35	3.71 3.75	3.73	7.67	7.67
3	17.20	96.06 95.99	96.03	14.97 15.02	15.00	1.70 1.61	1.66	7.62	7.62
4	32.64	92.89 92.10	92.50	10.19 10.20	10.20	34.20 34.26	34.23	3.04	3.04
5	25.89	93.09	93.09	12.66 12.56	12.61	16.16 15.60	15.88	6.08	6.08
6	31.30	96.86 97.06	96.96	9.87 9.78	9.83	35.87 35.46	35.67	4.26	4.26
7	22.43	93.54 93.50	93.52	14.24 14.25	14.25	7.52 7.44	7.47	5.51	5.51
8	22.75	93.74 93.78	93.76	13.70 13.74	13.72	10.38 10.23	10.34	4.67	4.67
9	31.08	96.06 96.13	96.10	9.94 9.92	9.93	35.43 35.39	35.41	3.83	3.83
10	36.40	95.48 95.45	95.47	9.19 9.18	9.19	39.06 39.14	39.10	4.26	4.26
11	17.61	94.34	94.34	15.52 15.47	15.50	2.31 2.46	2.39	7.60	7.60
12	22.67	94.96 95.04	95.00	14.39 14.44	14.42	5.85 5.73	5.79	5.91	5.91
13	28.36	90.85 90.65	90.75	10.85 10.93	10.89	27.24 27.28	27.26	4.83	4.83
14	34.22	95.86 96.09	95.98	9.56 9.58	9.57	37.90 37.98	37.94	3.35	3.35
15	21.96	92.44 92.57	92.51	13.78 13.70	13.74	7.13 7.22	7.18	6.88	6.88
16	20.20	97.23 97.75	97.50	15.09 15.06	15.08	1.05 0.65	0.85	5.82	5.82
17	37.04	84.30 84.14	84.22	9.06 9.02	9.04	40.10 40.18	40.14	4.33	4.33
18	34.01	88.70 88.76	88.73	12.15 12.16	12.16	21.54 21.48	21.51	5.36	5.36
19	21.97	92.70 92.73	92.72	13.41 13.38	13.40	10.50 10.48	10.49	6.66	6.66
20	23.56	96.34 88.56	92.45	14.84 14.80	14.82	2.87 2.83	2.85	5.82	5.82
21	19.76	90.93 90.94	90.94	14.81 14.76 14.75	14.77	0.78 0.77	0.78	8.72	8.72
22	15.88	94.10 94.18	94.14	14.13 14.17 14.11	14.14	5.33 5.03	5.18	8.63	8.63
23	20.51	96.70 96.72	96.71	13.27 13.36	13.32	9.75 9.76	9.76	10.08	10.08
24	23.58	95.21 95.22	95.22	13.24 13.26	13.25	11.61 11.61	11.61	6.33	6.33
25	47.27	96.52 96.65	96.59	9.18 9.22	9.20	0.72 0.70	0.71	50.72	50.72
26	25.00	90.40 90.88	90.64	13.90 14.01	13.96	8.58 8.58	8.58	5.86	5.86
27	44.40	84.09 83.97	84.03	8.76 8.75	8.76	51.51 51.66	51.59	2.80	2.80
28	50.26	97.43 97.33	97.38	6.04 6.03	6.04	31.89 31.92	31.90	31.01	31.01
29	35.46	96.35 96.12	96.24	9.89 9.84	9.87	32.94 31.85	32.40	5.24	5.24
30	26.66	97.01 96.98	97.00	11.23 11.26	11.25	27.03 27.05	27.04	5.02	5.02
31	31.00	90.41 90.45	90.43	10.75 10.78	10.77	28.05 28.02	28.04	4.81	4.81
32	33.78	86.53 86.65	86.58	9.87 9.92	9.90	34.63 34.37	34.50	4.58	4.58
33	71.61	93.42 89.38	91.40	9.04 9.01	9.03	24.20 24.16	24.18	20.15	20.15

Details of analyses of flesh of specimens of fish—Continued.

[Determinations of water, nitrogen, ether extract (fat), and ash.]

Laboratory No. of specimen.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	Per cent.	Per ct.	Per cent.	Per ct.	Per cent.	Per ct.	Per cent.	Per ct.
34	47.66	97.32 97.32	97.32	8.59 8.57	8.58	0.51 0.55	0.53	53.82	53.82
35	25.44	97.22 97.16	97.19	12.38 12.40	12.39	17.65 17.66	17.66	4.51	4.51
36	23.87	91.27 91.34	91.31	12.86 12.99	12.93	13.02 12.94	12.98	5.36	5.36
37	47.47	97.80 97.95	97.88	8.93 8.89	8.91	0.94 0.94	0.94	52.43	52.43
38	24.14	95.41 95.49	95.45	13.41 13.42	13.42	12.17 12.22	12.20	5.54	5.54
39	36.96	97.39 97.33	97.36	8.48 8.47	8.48	45.33 45.23	45.28	4.11	4.11
40	....	94.34 94.29	94.32	11.72 11.68	11.70	18.25 17.99	18.12	5.76	5.76
41	....	92.72 92.78	92.76	13.25 13.27	13.26	9.46 9.26	9.36	5.76	5.76
42	58.80	98.27 98.37	98.32	5.88 5.82	5.85	39.21 38.95	39.08	22.76	22.76
43	33.36	95.64 95.60	95.62	10.77 10.75	10.76	29.55 29.56	29.56	4.71	4.71
44	25.72	94.72 94.72	94.72	11.76 11.82	11.79	23.09 23.05	23.07	4.56	4.56
45	27.02	87.88 87.85	87.87	13.56 13.60	13.58	10.67 10.73	10.70	6.63	6.63
46	24.82	97.81 97.58	97.63	13.58 13.59	13.59	10.39 10.45	10.42	5.27	5.27
47	31.45	98.47 98.46	98.46	9.85 9.88	9.87	35.50 35.60	35.55	4.83	4.83
48	31.32	89.43 89.22	89.33	11.91 11.89	11.90	24.21 23.82	24.02	3.93	3.93
49	33.33	85.87 85.82	85.85	8.26 8.24	8.25	50.43 50.29	50.36	4.47	4.47
52	21.16	95.69 95.79	95.74	14.67 14.66	14.67	2.31 2.31	2.31	6.75	6.75
53	24.86	86.08 86.04	86.06	14.55 14.53	14.54	4.45 4.49	4.47	5.57	5.57
77	44.40	82.17 82.65	82.41	9.42 9.52	9.47	40.74 41.22	40.98	4.26	4.26
78	36.80	94.97 94.82	94.90	9.63 9.79	9.71	38.51 37.89	38.20	4.19	4.19
79	....	84.80 84.70	84.75	14.68 14.73	14.71	2.28 2.25	2.27	9.69 9.87	9.78
80	....	88.40 88.30	88.35	13.01 13.06	13.04	5.57 5.51	5.54	13.41 13.38	13.40
81	28.70	83.50 83.60	83.55	14.41 14.42 14.39	14.41	3.24 3.21	3.23	6.47 6.43	6.45
87	45.10	96.65 96.70	96.68	9.11 9.13	9.12	29.17 29.10	29.14	12.90 12.79	12.85
88	29.20	96.45 96.50	96.48	13.56 13.59	13.58	0.62 0.62	0.62	13.09 13.11	13.10
90	32.20	92.85 92.90	92.88	9.59 9.61	9.60	36.84 36.76	36.80	3.80 3.83	3.82
91	32.05	84.35 84.30	84.33	13.77 13.81	13.79	9.71 9.66	9.69	4.98 4.87	4.93
94	35.20	90.50 90.50	90.50	9.87 9.87	9.87	27.29 27.26	27.28	10.27 10.06	10.17
95	72.00	77.70 77.80	77.75	4.67 4.69	4.68	49.19 49.24	49.22	21.98 22.20	21.09
96	38.70	98.25 98.30	98.28	8.47 8.49	8.48	38.54 38.55	38.55	9.18 9.49	9.34
98	23.89	84.60 84.55	84.58	14.75 14.81	14.78	2.84 2.90	2.87	4.99 5.14	5.07
99	25.20	73.20 73.23	73.22	14.93 14.96	14.95	2.05 2.11	2.08	5.34 5.30	5.32
100	21.26	94.85 94.85	94.85	14.60 14.65	14.63	2.58 2.58	2.58	6.22 6.06	6.14
110	18.51	97.20 97.15	97.18	15.11 15.10	15.10	0.95 0.93	0.94	5.02 4.94	4.98

Details of analyses of flesh of specimens of fish—Continued.

[Determinations of water, nitrogen, ether extract (fat), and ash.]

Laboratory No. of specimen.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
111	24.48	97.48 97.43	97.46	12.93 12.91	12.92	14.58 14.60	14.59	5.28 5.21	5.25
113	17.63	95.83 95.80	95.82	14.56 14.55	14.56	3.98 3.96	3.97	5.74 5.79	5.77
114	21.11	95.00 95.00	95.00	14.86 14.90	14.88	2.41 2.37	2.39	5.81 5.76	5.79
126	28.16	89.15 89.20	89.18	12.38 12.42	12.40	18.46 18.44	18.45	4.63 4.68	4.66
127	21.16	92.50 92.50	92.50	14.52 14.55	14.54	2.81 2.81	2.81	5.87 5.84	5.86
205	26.50	70.34 70.30	70.32	15.14 15.10	15.12	2.92 2.98	2.95	3.48 3.48	3.48
206	21.23	90.85 90.90	90.88	15.23 15.17	15.20	1.54 1.54	1.54	7.26 7.18	7.22
207	22.36	97.67 97.60	97.64	13.65 13.67	13.66	7.53 7.58	7.55	6.22 6.25	6.24
208	26.52	82.65 82.70	82.68	14.36 14.37	14.37	5.08 5.13	5.11	6.14 6.09	6.12
211	24.48	94.05 94.06	94.06	13.70 13.63	13.67	11.94 11.97	11.95	3.80 3.83	3.81
212	33.19	87.34 87.26	87.30	10.08 10.04	10.06	35.32 35.32	35.32	3.13 3.05	3.09
217	28.20	94.36 94.32	94.34	10.68 10.67	10.68	29.57 29.67	29.62	4.14 4.18	4.16
218	53.53	97.70 97.70	97.70	7.02 7.06	7.04	27.60 27.62	27.61	28.40 28.44	28.42
219	85.91	65.60 65.61	65.61	5.10 5.06	5.08	44.05 44.05	44.05	24.58 24.48	24.53
220	31.79	85.10 85.05	85.08	11.68 11.66	11.67	22.29 22.27	22.28	5.50 5.46	5.48
221	29.33	95.53 95.57	95.55	11.49 11.46	11.48	23.25 23.23	23.24	5.48 5.44	5.46
224	21.91	93.47 93.55	93.51	14.89 14.83	14.86	2.40 2.35	2.38	5.44 5.47	5.46
225	23.77	95.65 95.55	95.60	13.34 13.38	13.36	12.36 12.34	12.35	4.92 4.92	4.92
228	17.28	95.85 95.90	95.88	15.32 15.28	15.30	1.89 1.89	1.89	5.99 6.06	6.03
229	18.07	96.53 96.55	96.54	14.99 14.95	14.97	1.82 1.82	1.82	6.79 6.76	6.78
230	26.88	97.92 97.95	97.94	11.83 11.87	11.85	22.25 22.30	22.28	4.61 4.58	4.60
233	39.31	90.27 90.23	90.25	8.34 8.39	8.37	46.51 46.51	46.51	2.86 2.84	2.85
234	34.88	93.42 93.45	93.44	9.03 8.97	9.00	41.38 41.42	41.40	2.92 2.98	2.95
236	29.09	99.35 99.28	99.31	8.31 8.28	8.30	46.01 46.05	46.03	2.27 2.27	2.27
237	26.03	93.10 93.14	93.12	12.91 12.89	12.90	15.03 15.01	15.02	5.25 5.20	5.23
238	22.02	96.74 96.65	96.70	13.64 13.62	13.63	8.90 8.90	8.90	6.75 6.68	6.72
240	27.89	97.80 97.71	97.76	12.73 12.71	12.72	14.87 14.81	14.84	6.16 6.21	6.19
241	44.03	96.40 96.40	96.40	7.34 7.34	7.34	50.62 50.62	50.62	4.19 4.11	4.15
242	21.29	94.88 94.81	94.85	15.26 15.25	15.26	2.67 2.67	2.67	6.43 6.53	6.48
243	19.02	93.55 93.60	93.58	15.10 15.10	15.10	2.89 2.89	2.89	6.92 6.97	6.95
244	23.02	88.48 88.41	88.45	14.84 14.88	14.86	3.03 3.07	3.05	5.03 5.06	5.05
245	31.28	89.00 89.07	89.04	10.60 10.54	10.57	29.11 29.09	29.10	5.53 5.50	5.52
246	29.94	96.01 96.07	96.04	11.64 11.60	11.62	13.16 13.15	13.16	5.28 5.34	5.31
247	20.99	85.03 85.00	85.02	16.28 16.29 16.30	16.29	7.81 7.81	7.81	6.35 6.41	6.38

Details of analyses of flesh of specimens of fish—Continued.

[Determinations of water, nitrogen, ether extract (fat), and ash.

Laboratory No. of specimen.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
248	25.44	86.98 87.00	86.99	13.73 13.71	13.72	9.93 9.93	9.93	5.06 5.03	5.05
249	27.46	96.33 96.28	96.31	11.05 11.06	11.06	26.58 26.58	26.58	5.14 5.17	5.16
250	22.03	94.93 94.98	94.96	14.83 14.79	14.81	3.16 3.16	3.16	6.37 6.34	6.36
251	22.99	89.98 89.97	89.98	15.33 15.34	15.34	2.38 2.34	2.36	6.82 6.77	6.80
252	22.67	91.67 91.72	91.70	14.55 14.58	14.57	4.52 4.54	4.53	5.66 5.70	5.68
253	15.97	98.00 98.00	98.00	14.88 14.84	14.86	2.86 2.84	2.85	7.70 7.65	7.68
254	20.67	97.55 97.57	97.56	14.93 14.91	14.92	3.71 3.73	3.72	4.77 4.73	4.75
255	35.42	86.10 86.13	86.12	10.21 10.16	10.19	33.45 33.49	33.47	3.84 3.86	3.85
256	24.51	98.82 98.83	98.83	13.40 13.42	13.41	12.14 12.14	12.14	5.06 5.10	5.08
257	19.51	98.12 98.15	98.14	14.96 14.92	14.94	3.94 3.96	3.95	5.86 5.94	5.90
258	21.79	98.33 98.33	98.33	13.42 13.43	13.43	10.98 10.98	10.98	5.57 5.54	5.56
259	18.61	97.40 97.43	97.42	15.29 15.25	15.27	1.95 1.91	1.93	5.70 5.72	5.71
260	23.67	98.68 98.65	98.67	12.33 12.30	12.32	19.75 19.75	19.75	3.92 3.91	3.92
261	26.05	94.28 94.28	94.28	12.66 12.67	12.66	17.14 17.12	17.13	5.25 5.20	5.23
262	29.33	91.00 91.00	91.00	11.64 11.65	11.65	22.53 22.55	22.54	5.24 5.19	5.22
263	24.91	87.55 87.60	87.58	14.18 14.14	14.16	7.49 7.53	7.51	4.71 4.67	4.69
269	26.48	81.38 81.46	81.42	14.08 14.06	14.07	6.73 6.65	6.69	6.32 6.28	6.30
270	19.12	96.40 96.45	96.43	14.63 14.67	14.65	2.86 2.92	2.89	6.65 6.69	6.67
271	24.08	87.37 87.45	87.41	15.07 15.04	15.06	3.52 3.59	3.55	5.39 5.45	5.42
273	21.59	97.40 97.41	97.41	13.54 13.53	13.54	11.40 11.34	11.37	5.58 5.70	5.64
275	31.73	98.59 98.52	98.56	11.39 11.41	11.40	7.22 7.14	7.18	23.16 23.11	23.14
279	41.21	93.74 93.76	93.75	10.24 10.24	10.24	33.80 33.72	33.76	3.49 3.52	3.51
280	44.61	87.38 87.36	87.37	10.17 10.17	10.17	33.50 33.56	33.53	3.70 3.75	3.73

Details of analyses of flesh of specimens of fish.

[Determinations of phosphorus, sulphur, and chlorine, recovered in water-free substances.]

Laboratory number of specimen.	Phosphorus, as P_2O_5.		Sulphur, as SO_3.		Chlorine, Cl.	
	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	2.10 2.11	2.11	2.09 2.13	2.11	...	...
2	1.88 1.83	1.86	2.23 2.23	2.23	...	...
3	2.21 2.16	2.19	...	...	...	...
4	1.66 1.74	1.70	...	...	...	...
5	2.06 2.06	2.06	...	...	...	...
7	2.36 2.66	2.51	...	...	...	...
8	2.25 2.27	2.26	...	...	...	...
9	1.51 1.51	1.51	...	...	...	...
10	1.93 1.95	1.94	...	...	...	...
11	3.19 3.17	3.18	...	...	...	...
12	2.87 2.98	2.93	...	...	...	...
13	2.46 2.39	2.43	...	...	...	...
14	1.79 1.78	1.79	...	...	...	...
15	3.04 3.03	3.04	...	...	...	...
16	2.34 2.52	2.43	...	...	...	...
17	1.84 1.76	1.80	1.95 1.93	1.94	...	...
18	2.31 2.38	2.35	1.35 1.37	1.36	...	...
19	2.15 2.16	2.16	2.28 2.27	2.28	...	...
20	2.13 2.17	2.15	2.15 2.22	2.19	...	...
21	2.52 2.56	2.54	2.23 2.29	2.26	...	...
22	2.74 2.65	2.70	3.12 3.07	3.10	...	...
23	4.05 4.15	4.10	2.78 2.79	2.79	...	...
24	2.70 2.70	2.70	2.10 2.16	2.13	...	...
25	0.79 0.79	0.79	1.50 1.47	1.48	24.53 24.50	24.51
26	2.02 2.18	2.10	2.06 2.07	2.07	...	...
27	1.82 1.90	1.86	1.14	1.14	...	...
28	0.98 0.91	0.95	0.90 0.87	0.89	17.64 17.75	17.69
29	1.77 1.77	1.77	1.27 1.27	1.27	...	...
30	2.15 2.16	2.16	1.66 1.69	1.68	...	...
31	1.99 1.97	1.98	1.84	1.84	...	...
32	1.74 1.77	1.76	1.79 1.78	1.78	0.75 0.73	0.74
33	1.27 1.29	1.28	1.88 1.89	1.89	11.10 10.92	11.01
34	0.61 0.61	0.61	1.56 1.56	1.56	25.71 25.61	25.66
35	1.89 1.88	1.89	1.56 1.59	1.58	0.73 0.75	0.74
36	2.20 2.20	2.20	1.46 1.44	1.45	0.84 0.85	0.85
37	0.49 0.46	0.48	1.61 1.61	1.61	25.68 25.74	25.71
38	2.25 2.22	2.24	1.95 1.98	1.97	1.02 1.04	1.03

Details of analyses of flesh of specimens of fish—Continued.

[Determinations of phosphorus, sulphur, and chlorine, recovered in water-free substances.]

Laboratory number of specimen.	Phosphorus, as P_2O_5. Individual determinations.	Phosphorus, as P_2O_5. Average.	Sulphur, as SO_3. Individual determinations.	Sulphur, as SO_3. Average.	Chlorine, Cl. Individual determinations.	Chlorine, Cl. Average.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
39	1.60 1.60	1.60	1.42 1.42	1.42	0.68 0.68	0.68
40	2.40 2.21	2.31	1.73 1.81	1.77	0.94 0.96	0.95
41	2.38 2.48	2.43	1.99 1.96	1.98	0.93 0.93	0.93
42	0.61 0.61	0.61	1.07 1.03	1.05	....	....
43	1.91 1.85	1.88	1.80 1.81	1.81	....	....
44	1.41 1.51	1.46	2.50 2.57	2.54	....	....
45	2.19 2.23	2.21	1.50 1.59	1.55	....	....
46	2.13 2.12	2.13	2.83 2.76	2.80	....	....
47	1.77 1.76	1.77	1.75 1.78	1.77	....	....
48	1.64 1.59	1.62	1.71 1.70	1.71	....	....
49	1.67 1.65	1.66	1.12 1.11	1.12	....	....
52	2.26 2.21	2.24	4.38 4.48	4.43	....	....
53	2.02 2.05	2.04	4.08 4.20	4.14	....	....

4. TABULAR STATEMENTS SHOWING THE RESULTS OF THE ANALYSES OF AMERICAN FISHES.

EXPLANATION OF TABLES.

Tables 1 to 9 recapitulate the results of the analyses of American fishes.

Table 1 gives the localities of the specimens as stated by the parties from whom they were received, the portions received for analysis, results of weighings in preparing for analysis, etc. The "loss in preparing for analysis" I suppose to have consisted chiefly of water which evaporated during the process, and of material which adhered to the hands and the instruments with which the separations were made. The specimens are here arranged, for convenience, in numerical order. The full descriptions and details regarding the specimens were given in the previous chapter.

Table 2 gives results of analyses of flesh calculated on water-free substance. It will be observed that the percentages of protein as estimated by multiplying the nitrogen by the factor 6.25, and those of "albuminoids, etc.," (actual nitrogenous substances) as estimated by difference [100−(ether extract+ash)=albuminoids, etc.], are both given. The former (protein=N×6.25) has the sanction of common usage, but the latter comes nearer to the truth. We certainly can not go far away in assuming that the flesh of fish contains ordinarily but very little of non-nitrogenous compounds other than fats and mineral compounds, though

a more thorough study of the carbohydrates and complex nitrogenous and phosphorized fats is much needed. Accordingly it seems to me that in these analyses the most accurate measure of the nitrogenous compounds is to be found by subtracting the sum of the ether extract and ash from the whole.

Table 3 gives analyses of flesh calculated on fresh substance, and includes both protein as estimated by multiplying N by 6.25, and "albuminoids, etc.," by difference [100−(water+ether extract+ash)=albuminoids, etc.] The figures of this table are computed from those of Table 2, the percentages of water and water-free substance in the flesh and of ingredients in water-free substance serving as the basis of the calculations. In the subsequent tables, deduced from these and taken as representing the actual composition of the flesh, the latter figures rather than those obtained by multiplying N by 6.25 are taken as representing the nitrogenous matters.

Table 4 gives the proportions of proximate ingredients in the water-free (dry) substance of specimens of American preserved fish. It corresponds to Table 2, which gives the same ingredients in water-free substance of fresh fish.

Table 5 gives the proportions of proximate ingredients in the flesh of American preserved fish, corresponding to Table 3 of fresh fish.

Table 6 gives the proportions of proximate ingredients in the water-free substance of the flesh of American fishes as directly determined; that is to say, it recapitulates the determinations of extractive matters, albumen, gelatin, insoluble protein, etc., as made in accordance with the statements in the chapter on Methods of Analysis. The figures for ether extract and ash are those of the previous tables. As there stated, I do not consider the determinations of the nitrogenous constituents entirely accurate. The methods are not yet well enough worked up to give satisfactory results. The figures will, nevertheless, serve for comparison with those obtained by Almén,* and, I presume, with those of Kostytschef.* It is to be noted, however, that the figures here given refer simply to the flesh, while those of Almén I understand to include the skin with the flesh, and I presume that the same may be the case with Kostytschef's, though as to the latter point I am not definitely informed. The last column of Table 6 gives the sums of the several constituents. These vary more or less from 100 per cent., and they thus indicate errors in the determination. Where these footings have varied by more than 5 per cent. from 100 per cent. in the water-free substance (which would correspond to from 1 per cent. to 2 per cent. in the fresh flesh), the insoluble protein for each specimen has been omitted from the table. The methods of estimating the extractive matters, gelatin, and insoluble protein differ in the different specimens with respect to the determinations of ash and fat, as indicated in the table and stated in full in the details of the analyses.

* See beyond, Section B, Division 2, Recapitulation of Analyses of European Fishes.

I have deemed it proper to state the precise facts with reference to these analyses, so that they may be taken exactly for what they are worth. The analytical details will help in judging properly of their value. As stated in the description of the method of analysis, the methods were those laid down by other analysts. We followed those methods and did the work as faithfully as we were able. If the results have no other value, they at least show the need of working up the methods more thoroughly.

Table 7 gives the proximate ingredients of the flesh as directly determined. The analyses are those of Table 6 calculated on fresh substance, the figures for water being those stated in previous tables.

Table 8 states the percentages of phosphorus calculated as P_2O_5 and as PO_4, of sulphur as SO_3 and as SO_4, and of chlorine, in both water-free substance and fresh substance of flesh. The determinations were made as described in the chapter on Methods of Analysis, and I believe them to be reasonably accurate.

The composition of the specimens of fresh and preserved fish as received for analysis, including both flesh and other parts, is stated in Table 9.

OTHER ANALYSES OF AMERICAN FISHES.

Prof. R. H. Chittenden has reported an analysis of the flesh of halibut, "a fresh sample obtained in the market."* The source of the specimen, the season in which it was taken, and the portion of the body used for analysis are not stated. It appears, however, to have been rather lean in comparison with the specimens of halibut above reported. To facilitate such comparison, I give the result in the forms followed in the tables here, basing the calculations on the averages of Professor Chittenden's analyses, which from their close agreement, as well as from the context, I take to be duplicate determinations of the same specimen of flesh.

Composition of flesh of halibut.

[In water-free substance, "flesh dried at 100° C."]

	P. ct.
Nitrogen	11.68
Protein, N × 6.25	73.00
Fats	7.12
Ash	6.35
Protein (N × 6.25) + fats + ash	86.47
Albuminoids, etc., by difference	86.53

Prof. G. H. Cook has reported an analysis of menhaden, *Brevoortia tyrannus*,† which was, however, made for the purpose of learning the value of the fish for fertilizing the soil, and yielded no data that could well be utilized here. No other analyses of flesh of American food-fishes have come to my attention.

* Am. Jour. Sci. [3], 13, 123. † Geology of New Jersey, p. 498.

TABLE 1.—*List of specimens of American fishes analyzed, names, localities, and proportions of flesh, etc.*

Kinds of fish, localities, and portion taken for analysis.	Laboratory No. of specimen.	When received.	Number of fish in specimen.	Proportion of flesh, etc., in specimen as taken for analysis. Total weight of specimen.			Flesh, edible portion.	Refuse, bones, skin, entrails, etc.	Loss in preparation for analysis.
				Lbs.	Oz.	Grams.	Per ct.	Per ct.	Per ct.
Halibut (Hippoglossus hippoglossus), posterior part of body, lean	1	Spring, 1879	..	4	2.7	1894.0	75.92	23.12	0.96
Common flounder (Paralichthys dentatus), entrails removed	2	....do	2	5	1.2	2308.0	41.33	57.02	1.65
Cod (Gadus morrhua), head and entrails removed	3	....do	1	6	1.9	2780.0	64.57	33.70	1.73
Eel, salt water (Anguilla rostrata), skin, head, and entrails removed	4	....do	11	3	0.1	1368.0	76.24	21.42	2.34
Alewife (Clupea vernalis), whole, Connecticut River	5	....do	12	1	14.2	859.0	49.48	50.52	0.00
Shad (Clupea sapidissima), whole, Hudson River, first of season	6	....do	2	4	3.8	1925.0	48.31	49.35	2.34
Striped bass (Roccus lineatus), whole, Connecticut River	7	....do	1	4	8.4	2055.0	42.09	56.69	1.22
Mackerel (Scomber scombrus), whole	8	....do	4	2	13.0	1280.0	60.55	38.28	1.17
Halibut (Hippoglossus hippoglossus), section of body, fatter than No. 1	9	....do	....	2	6.0	1075.0	88.28	11.16	0.56
Shad (Clupea sapidissima), whole, Connecticut River, early in season	10	....do	1	3	8.2	1595.0	52.35	46.40	1.25
Cod (Gadus morrhua), head and entrails removed	11	....do	1	5	9.2	2532.0	68.13	30.57	1.30
Bluefish (Pomatomus saltatrix), entrails removed	12	....do	1	3	1.3	1400.0	50.14	48.57	1.29
Mackerel (Scomber scombrus), whole	13	....do	2	1	15.7	898.2	45.76	51.77	2.47
Salmon (Salmo salar), entrails removed, Maine	14	....do	1	10	8.0	4764.3	76.16	23.84	0.00
Porgy (Diplodus argyrops), whole	15	....do	4	2	9.9	1190.5	33.16	65.17	1.67
Haddock (Gadus æglefinus), entrails removed	16	....do	1	4	2.9	1900.0	46.84	51.42	1.74
Lake trout, "Mackinaw trout" (Salvelinus namaycush), whole, Lake Ontario	17	November, 1879	1	7	14.8	3600.4	43.31	56.32	0.37
Whitefish (Coregonus clupeiformis), whole, Lake Champlain	18	....do	1	2	14.3	1313.0	45.76	53.47	0.77
Striped bass (Roccus lineatus), whole, Bridgehampton, Long Island	19	....do	1	2	6.7	1098.5	42.51	56.90	0.59
Red snapper (Lutjanus blackfordi), whole, Fernandina, Florida	20	....do	1	7	11.7	3507.5	60.00	39.60	0.40
Haddock (Gadus æglefinus), entrails removed, Rockaway, Long Island	21	....do	1	5	4.7	2402.2	47.50	51.62	0.88
Common flounder (Paralichthys dentatus), whole, Amagansett, Long Island	22	March, 1880	1	2	12.3	1257.5	31.97	66.80	1.23
Smelt (Osmerus mordax), whole, Hackensack River, New Jersey	23	....do	73	2	4.0	1023.0	61.78	34.82	3.40
Brook trout (Salvelinus fontinalis), whole, cultivated, Long Island	24	....do	6	2	13.6	1295.0	46.95	50.11	2.94
Red snapper (Lutjanus blackfordi), entrails removed, Florida, east coast	26	April, 1880	1	12	1.6	5498.7	47.36	52.45	0.19
Mackerel (Scomber scombrus), whole, Cape May, New Jersey	30	May, 1880	4	5	11.3	2594.0	50.29	48.85	0.86
Porgy (Diplodus argyrops), whole, Rhode Island	31	....do	4	6	4.6	2857.0	41.65	57.33	1.02
Shad (Clupea sapidissima), whole, Connecticut River	32	....do	1	3	13.7	1752.0	52.80	45.89	1.31
Blackfish (Hiatula onitis), whole, Stonington, Connecticut	38	December, 1880	2	4	8.6	2060.0	42.16	56.15	1.69
Mackerel (Scomber scombrus), whole, Cape Cod, Massachusetts	39	....do	1	1	2.4	522.1	64.60	33.78	1.62
Spanish mackerel (Cybium maculatum), whole	43	March, 1881	1	3	5.2	1512.4	64.02	34.61	1.37
White perch (Roccus americanus), whole	44	....do	2	1	11.1	770.1	35.24	63.24	1.52
Muskellunge (Esox nobilior), whole, St. Lawrence River	45	....do	1	9	1.0	4118.0	50.57	49.23	0.20
White perch (Roccus americanus), whole	46	....do	4	2	0.9	935.9	36.24	61.80	1.96
Herring (Clupea harengus), whole	47	....do	4	2	6.0	1080.8	51.13	46.00	2.87
Sheepshead (Diplodus probatocephalus), entrails removed, Florida	48	....do	1	4	5.5	1974.2	42.07	56.59	1.34
Turbot, or Greenland halibut (Platysomatichthys hippoglossoides), whole, Newfoundland	49	....do	1	5	8.0	2496.5	52.27	46.04	1.69
Pike perch, or wall-eyed pike (Stizostedion vitreum), whole	52	....do	2	2	7.5	1122.7	41.21	57.25	1.54
Large-mouthed black bass (Micropterus salmoides), whole, North Carolina	53	....do	1	3	11.1	1676.5	43.16	56.05	0.79

Salmon (Salmo salar), whole, Penobscot River	77	July, 1881	1	13	1.8	5948.0	66.54	32.98	0.48
Salmon (Salmo salar), whole, Penobscot River	78	... do	1	11	3.3	5082.0	69.22	30.56	0.22
Pollock (Gadus virens), head and entrails, removed, Massachusetts coast	81	October, 1881	1	5	13.1	2638.0	69.64	28.50	1.86
Butter-fish (Stromateus triacanthus), whole, east end of Long Island	90	November, 1881	4	1	9.6	724.0	55.86	42.76	1.38
Small-mouthed black bass (Micropterus dolomieu), whole, Seneca Lake, New York	91	... do	2	1	11.2	772.8	45.36	53.66	0.98
Pike or pickerel (Esox lucius), entrails removed, Lake Ontario	98	... do	1	3	9.0	1617.0	55.69	42.67	1.64
Tomcod (Gadus tomcod), whole, south side of Long Island	99	... do	4	2	7.6	1131.6	39.06	59.88	1.06
Pickerel (Esox reticulatus), whole, Seneca Lake, New York	100	... do	3	2	2.5	960.6	53.14	45.44	1.42
Cusk (Brosmius brosme), entrails removed, Massachusetts coast	110	December, 1881	1	3	2.7	1436.5	58.40	40.28	1.32
Cisco (Coregonus sp. tullibee or artedi?), whole, Lake Erie	111	... do	4	2	12.4	1256.0	55.95	42.70	1.35
Hake (Phycis chuss), entrails removed, off Coney Island, New York	113	... do	1	14	6.5	6534.5	47.54	52.46	0.00
Grouper (Epinephelus morio), entrails removed, Pensacola, Florida	114	... do	1	3	7.0	1559.0	43.55	55.77	0.68
Mullet (Mugil albula), whole, Virginia	126	... do	1	1	8.9	707.5	40.99	57.88	1.13
Yellow perch (Perca fluviatilis), whole, Lake Champlain	127	... do	4	2	8.8	1152.0	36.56	62.64	0.80
Black fish (Hiatula onitis), whole	205	March, 1882	1	3	3.0	1446.5	33.95	64.08	1.97
Cod, "rock cod" (Gadus morrhua), whole, near Block Island	206	... do	1	4	2.3	1881.0	42.85	56.51	0.64
Smelt (Osmerus mordax), whole, Maine coast	207	... do	14	0	14.0	398.0	47.99	48.99	3.02
Yellow perch (Perca fluviatilis), head, entrails, fins, and tail removed, Connecticut River	208	... do	6	0	10.7	302.0	60.60	35.10	4.30
Halibut (Hippoglossus hippoglossus), sections of different parts of body, George's Banks	211	... do	....	8	2.7	3705.0	79.52	18.70	1.78
Shad (Clupea sapidissima), whole, Delaware River	212	... do	1	2	10.2	1196.0	53.77	44.39	1.84
Eel (salt water) (Anguilla rostrata), head, skin, and entrails removed, north coast of Long Island	217	April, 1882	6	0	15.4	436.0	76.14	19.04	4.82
Alewife (Clupea vernalis), whole, Connecticut River	220	... do	4	1	14.8	879.2	47.90	49.42	2.68
Shad (Clupea sapidissima), whole, Connecticut River	221	... do	1	3	3.5	1461.0	45.18	53.25	1.57
Pickerel (Esox reticulatus), whole, Connecticut River	224	... do	2	1	5.2	600.0	48.16	48.67	3.17
Striped bass (Roccus lineatus), whole, Long Island Sound	225	... do	1	2	7.9	1132.0	49.63	48.59	1.78
Cod (Gadus morrhua), head and entrails removed	228	... do	1	7	7.4	3387.0	72.90	25.54	1.56
Haddock (Gadus æglefinus), entrails removed	229	... do	1	3	4.2	1480.0	49.73	47.97	2.30
Mackerel (Scomber scombrus), entrails removed	230	... do	2	1	6.6	640.0	57.35	40.65	2.00
California salmon (Oncorhynchus chouicha), section of anterior part of body	233	... do	....	1	14.7	870.5	88.70	10.34	0.96
Pompano (Trachynotus carolinus), whole, Pensacola, Florida	234	... do	1	1	8.1	683.5	56.24	42.37	1.39
Lamprey eel (Petromyzon marinus?), whole, Hackensack River	236	... do	2	2	13.6	1295.0	50.40	45.79	3.81
Striped bass (Roccus lineatus), whole, North Carolina	237	... do	1	2	12.8	1270.0	41.37	57.08	1.55
Sturgeon (Acipenser sturio), section of anterior part of body, Delaware River	238	... do	...	1	10.6	753.0	84.72	14.41	0.87
Red snapper (Lutjanus blackfordi), entrails and gills removed, Pensacola, Florida	242	... do	1	4	1.2	1848.0	54.33	45.29	0.38
Cod (Gadus morrhua), whole, Long Island	243	... do	1	5	7.5	2481.0	49.78	48.53	1.69
Blackfish (Hiatula onitis), entrails removed, Massachusetts	244	... do	1	2	8.5	1147.0	40.80	57.81	1.39
Shad (Clupea sapidissima), whole, Hudson River	245	... do	1	3	7.7	1579.0	45.92	52.69	1.39
Skate (Raia sp.), left lobe of body	247	... do	....	4	11.9	2150.0	46.32	51.03	2.65
Striped bass (Roccus lineatus), whole, Long Island	248	... do	1	2	0.0	906.0	42.93	55.41	1.66
Shad (Clupea sapidissima), whole, North Carolina	249	... do	1	3	15.6	1801.0	39.75	58.75	1.50
Sheepshead (Diplodus probatocephalus), whole, North Carolina	250	... do	1	1	15.3	886.5	32.61	65.98	1.41
Sea bass (Centropristis atrarius), whole, Pensacola, Florida	251	... do	1	6	9.3	2985.0	43.84	56.09	0.07
Kingfish (Menticirrus nebulosus), whole, North Carolina	252	... do	1	1	8.2	685.5	42.16	56.60	1.24
Winter flounder (Pleuronectes americanus), whole, Rhode Island	253	... do	1	1	10.5	751.0	41.16	56.20	2.64
Brook trout (Salvelinus fontinalis), whole, cultivated, Long Island	254	... do	3	0	12.3	353.1	51.15	45.20	3.65
Lake trout "Mackinaw trout" (Salvelinus namaycush), entrails removed, Lake Ontario	255	... do	1	5	7.4	2477.0	63.58	35.21	1.21
Brook trout (Salvelinus fontinalis), whole, Montreal, Canada	256	... do	1	0	12.2	346.0	48.86	49.12	2.02
Pike perch or gray pike (Stizostedion canadense), whole, Cleveland, Ohio	257	... do	1	0	12.3	349.5	35.20	63.23	1.57
Small-mouthed red-horse (Moxostoma velatum), entrails removed, Cleveland, Ohio	258	... do	1	3	5.0	1500.0	46.20	52.47	1.33
Haddock (Gadus æglefinus), entrails removed, Long Island	259	... do	1	7	2.1	3235.0	46.09	52.89	1.02
Striped bass (Roccus lineatus), entrails removed, Long Island	260	... do	1	2	2.2	969.5	47.96	51.16	0.88
Mackerel (Scomber scombrus), whole, Virginia capes	261	... do	1	1	4.4	576.0	48.43	50.35	1.22

TABLE 1.—*List of specimens of American fishes analyzed, names, localities, and proportions of flesh, etc.*—Continued.

Kinds of fish, localities, and portion taken for analysis.	Laboratory No. of specimen.	When received.	Number of fish in specimen.	Proportion of flesh, etc., in specimen as taken for analysis.				
				Total weight of specimen.		Flesh, edible portion.	Refuse, bones, skin, entrails, etc.	Loss in preparation for analysis.
				Lbs. Oz.	*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*
Porgy (Diplodus argyrops), whole, Gravesend Bay, Long Island	262	April, 1882	1	1 15.6	896.0	41.70	57.58	0.72
Pompano (Trachynotus carolinus), whole, Pensacola, Florida	263	....do	1	2 1.5	949.0	50.39	48.56	1.05
Blackfish (Hiatula onitis), entrails removed, Rhode Island	269	May, 1882	1	2 10.0	1189.0	45.30	53.57	1.13
Red bass (Sciæna ocellata), whole, North Carolina	270	....do	1	6 11.1	3033.0	36.47	63.53	0.00
Red grouper (Epinephelus morio), entrails removed, Pensacola, Florida	271	....do	1	11 12.5	5344.0	44.05	55.95	0.00
Weakfish (Cynoscion regale), whole, Long Island	273	....do	2	2 0.0	909.4	47.01	51.89	1.10
Salmon (Salmo salar), female, whole, Penobscot River, Maine	279	June, 1882	1	11 3.5	5107.0	64.27	35.73	0.00
Salmon (Salmo salar), male, whole, Penobscot River, Maine	280	....do	1	12 10.0	5826.0	60.45	39.55	0.00
ROE.								
Shad roe, from shad No. 245	246	April, 1882	..	0 9.0	257.0	100.00	......	......
SPENT FISH.								
Salmon (Salmo salar), male, whole, Penobscot River, Maine	35	November, 1880	2	18 11.3	8482.7	55.72	43.78	0.50
Salmon (Salmo salar), female, whole, Penobscot River, Maine	36	....do	2	22 8.0	10204.9	56.19	43.54	0.27
Land-locked salmon (Salmo salar, subsp. sebago), male, whole, Grand Lake Stream, Maine	40	December, 1880	4	12 8.2	5686.3	50.74	48.41	0.85
Land-locked salmon (Salmo salar, subsp. sebago), female, whole, Grand Lake Stream, Maine	41	....do	4	7 15.6	3622.3	52.50	46.20	1.30
PRESERVED FISH.								
Boned cod (Gadus morrhua)	25	April, 1880	....	....	....	100.00	......	......
Smoked halibut (Hippoglossus hippoglossus)	28	....do	....	3 8.9	1616.0	91.34	8.04	0.62
Canned salmon (Oncorhynchus chouicha), California (Oregon)	29	....do	....	1 14.7	870.0	87.99	11.66	0.35
Smoked herring (Clupea harengus)	33	May, 1880	6	1 0.0	454.7	54.98	44.42	0.60
Salt cod (Gadus morrhua), "Channel fish," George's Banks	34	November, 1880	1	9 2.2	4145.7	74.02	25.47	0.51
Salt cod (Gadus morrhua), "Boat fish," vicinity of Nantucket, Mass	37	....do	1	6 3.1	2813.4	74.25	24.34	1.41
Salt mackerel (Scomber scombrus), No. 1 mackerel	42	February, 1881	3	1 11.5	781.4	72.28	22.91	4.81
"Alden's dried fresh cod" (Gadus sp.?), boned, dried, and ground	79	October, 1881	....	....	....	100.00	......	......
"Alden's dried salt cod" (Gadus sp.?), boned, dried, and ground	80	....do	....	....	....	100.00	......	......
Canned sardines (Clupea pilchardus?), Mediterranean Sea (?)*	87	November, 1881	...	0 10.9	309.2	94.15	5.04	0.81
"Findon haddie" (Smoked haddock), (Gadus æglefinus)	88	.. do	1	3 3.5	1460.0	65.07	33.22	1.71
Canned fresh mackerel (Scomber scombrus)	94	....do	....	1 0.5	468.5	100.00	......	......
Canned salt mackerel (Scomber scombrus), No. 2 mackerel	95	....do	2	1 0.2	460.0	82.17	16.96	0.87
Canned salmon (Oncorhynchus chouicha), Columbia River, Oregon	96	....do	...	1 0.7	474.0	100.00	......	......
Smoked halibut (Hippoglossus hippoglossus)	218	April, 1882	....	0 11.4	323.5	93.05	5.87	1.08
Canned salt mackerel (Scomber scombrus)	219	November, 1881	2	0 14.5	410.0	74.63	22.44	2.93
Canned tunny, "Horse mackerel" (Orcynus secundi-dorsalis?)	240	...do	....	0 12.8	361.5	100.00	......	......
Canned salmon (Oncorhynchus chouicha), Columbia River, Oregon	241	....do	....	1 0.6	470.0	100.00	......	......
Canned "findon haddie" (Smoked haddock), (Gadus æglefinus)	275	April, 1882	....	1 1.0	480.0	100.00	......	......

* This belongs more properly with European fishes, but is included here because it was analyzed with the American specimens.

TABLE 2.—*Composition of water-free substance of flesh of American fishes.*

Name of fish.	Laboratory No. of specimen.	Nitrogen.	Protein, N×6.25.	Fats. Ether extract.	Ash.	Protein+fats+ash.	Albuminoids, etc. (by difference).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sturgeon (Acipenser sturio)	238	13.63	85.19	8.90	6.72	100.81	84.38
Small-mouthed red-horse (Moxostoma velatum)	258	13.43	83.94	10.98	5.56	100.48	83.46
Herring (Clupea harengus)	47	9.87	61.69	35.55	4.83	102.07	59.62
Alewife (Clupea vernalis)	5	12.61	78.81	15.88	6.08	100.77	78.04
Do	220	11.67	72.94	22.28	5.48	100.70	72.24
Do (average of 2 specimens)		12.14	75.87	19.08	5.78	100.73	75.14
Shad (Clupea sapidissima)	6	9.83	61.44	35.67	4.26	101.37	60.07
Do	10	9.19	57.38	39.10	4.26	100.74	56.64
Do	32	9.90	61.88	34.50	4.58	100.96	60.92
Do	212	10.06	62.87	35.32	3.09	101.28	61.69
Do	221	11.48	71.75	23.24	5.46	100.45	71.30
Do	245	10.57	66.06	29.10	5.52	100.68	65.38
Do	249	11.06	69.13	26.58	5.16	100.87	68.26
Do (average of 7 specimens)		10.30	64.36	31.93	4.62	100.91	63.47
Smelt (Osmerus mordax)	23	13.32	83.25	9.76	10.08	103.09	80.16
Do	207	13.66	85.38	7.55	6.24	99.17	86.21
Do (average of 2 specimens)		13.49	84.31	8.65	8.16	101.13	83.19
Whitefish (Coregonus clupeiformis)	18	12.16	76.00	21.51	5.36	102.87	73.13
Cisco (Coregonus, sp. tullibee or artedi)	111	12.92	80.75	14.59	5.25	100.59	80.16
California salmon (Oncorhynchus chouicha)	27			51.59	2.98		45.43
Do	233	8.37	52.31	46.51	2.85	101.67	50.64
Do (average of 2 specimens)				49.05	2.92		48.03
Salmon (Salmo salar)	14	9.57	59.81	37.94	3.35	101.10	58.71
Do (female)	77	9.47	59.19	40.98	4.26	104.43	54.76
Do do	78	9.71	60.69	38.20	4.19	103.08	57.61
Do do	279	10.24	64.00	33.76	3.51	101.27	62.73
Do (male)	280	10.17	63.56	33.53	3.73	100.82	62.74
Do (average of 5 specimens)		9.83	61.45	36.88	3.81	102.14	59.31
Spent salmon (Salmo salar) (male)	35	12.39	77.44	17.66	4.51	99.61	77.83
Do (female)	36	12.93	80.81	12.98	5.36	99.15	81.66
Do (average of 2 specimens)		12.66	79.13	15.32	4.93	99.38	79.75
Spent land-locked salmon (Salmo salar, subsp. sebago) (male)	40	11.70	73.13	18.12	5.76	97.01	76.12
Do (female)	41	13.26	82.88	9.36	5.76	98.00	84.88
Do (average of 2 specimens)		12.48	78.00	13.74	5.76	97.50	80.50
Lake trout (Salvelinus namaycush)	17	9.04	56.50	40.14	4.33	100.97	55.53
Do	255	10.19	63.69	33.47	3.85	101.01	62.68
Do (average of 2 specimens)		9.62	60.10	36.80	4.09	100.99	59.11
Brook trout (Salvelinus fontinalis)	24	13.25	82.81	11.61	6.33	100.75	82.06
Do	254	14.92	93.25	3.72	4.75	101.72	91.53
Do	256	13.41	83.81	12.14	5.08	101.03	82.78
Do (average of 3 specimens)		13.86	86.62	9.16	5.39	101.17	85.46
Pickerel (Esox reticulatus)	100	14.63	91.43	2.58	6.14	100.15	91.28
Do	224	14.86	92.88	2.38	5.46	100.72	92.16
Do (average of 2 specimens)		14.74	92.15	2.48	5.80	100.43	91.72
Pike (Esox lucius)	98	14.78	92.38	2.87	5.07	100.32	92.06
Muskellunge (Esox nobilior)	45	13.58	84.87	10.70	6.63	102.20	82.67
Eel, salt-water (Anguilla rostrata)	4	10.20	63.75	34.23	3.04	101.02	62.73
Do	217	10.68	66.75	29.62	4.16	100.53	66.22
Do (average of 2 specimens)		10.44	65.25	31.92	3.60	100.77	64.48
Mullet (Mugil albula)	126	12.40	77.50	18.45	4.66	100.61	76.89
Mackerel (Scomber scombrus)	8	13.72	85.75	10.31	4.67	100.73	85.02
Do	13	10.89	68.06	27.26	4.83	100.15	67.91
Do	30	11.25	70.31	27.04	5.02	102.37	67.94
Do	39	8.48	53.00	45.28	4.11	102.39	50.61
Do	230	11.85	74.06	22.28	4.60	100.94	73.12
Do	261	12.66	79.10	17.13	5.23	101.46	77.64
Do (average of 6 specimens)		11.47	71.71	24.88	4.75	101.34	70.38
Spanish mackerel (Cybium maculatum)	43	10.76	67.25	29.56	4.71	101.52	65.73
Pompano (Trachynotus carolinus)	234	9.00	56.25	41.40	2.95	100.60	55.65
Do	263	14.16	88.50	7.51	4.69	100.70	87.80
Do (average of 2 specimens)		11.58	72.37	24.46	3.82	100.65	71.72
Bluefish (Pomatomus saltatrix)	12	14.42	90.13	5.79	5.91	101.83	88.30
Butter-fish (Stromateus triacanthus)	90	9.60	60.00	36.80	3.82	100.62	59.38
Large-mouthed black bass (Micropterus salmoides)	53	14.54	90.88	4.47	5.57	100.92	89.96
Small-mouthed black bass (Micropterus dolomieu)	91	13.79	86.19	9.69	4.93	100.81	85.38
Yellow perch (Perca fluviatilis)	127	14.54	90.88	2.81	5.86	99.55	91.33
Do	208	14.37	89.81	5.11	6.12	101.04	88.77
Do (average of 2 specimens)		14.46	90.34	2.96	5.99	100.29	90.05
Pike perch, Wall-eyed pike (Stizostedion vitreum)	52	14.67	91.69	2.31	6.75	100.75	90.94
Pike perch, Gray pike (Stizostedion canadense)	257	14.94	93.38	3.95	5.90	103.23	90.15

TABLE 2.—*Composition of water free substance of flesh of American fishes*—Continued.

Name of fish.	Laboratory No. of specimen.	Nitrogen.	Protein, N × 6.25.	Fats. Ether extract.	Ash.	Protein+fats+ash.	Albuminoids, etc. (by difference.
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Striped bass (Roccus lineatus)	7	14.25	89.05	7.47	5.51	102.03	87.02
Do	19	13.40	83.78	10.49	6.69	100.96	82.82
Do	225	13.36	83.50	12.35	4.92	100.77	82.73
Do	237	12.90	80.63	15.02	5.23	100.88	79.75
Do	248	13.72	85.75	9.93	5.05	100.73	85.02
Do	260	12.32	77.00	19.75	3.92	100.67	76.33
Do (average of 6 specimens)		13.32	83.28	12.50	5.22	101.00	82.28
White perch (Roccus americanus)	44	11.79	73.69	23.07	4.56	101.32	72.37
Do	46	13.59	84.94	10.42	5.27	100.63	84.31
Do (average of 2 specimens)		12.69	79.31	16.74	4.92	100.97	78 34
Sea bass (Centropristis atrarius)	251	15.34	95.88	2.36	6.80	105.04	90.84
Grouper (Epinephelus morio)	114	14.88	93.00	2.39	5.79	101.18	91.82
Do	271	15.06	94.13	3.39	5.42	102.94	91.19
Do (average of 2 specimens)		14.97	93.57	2.89	5.60	102.06	91.51
Red snapper (Lutjanus blackfordi)	20	14.82	92.63	2.85	5.82	101.30	91.33
Do	26	13.96	87.25	8.58	5.86	101.69	85.56
Do	242	15.26	95.38	2.67	6.48	104.53	90.85
Do (average of 3 specimens)		14.68	91.75	4.70	6.05	102.50	89.25
Porgy (Diplodus argyrops)	15	13.74	85.88	7.18	6.88	99.94	85.94
Do	31	10.77	67.31	28.04	4.81	100.16	67.15
Do	262	11.65	72.81	22.54	5.22	100.57	72.24
Do (average of 3 specimens)		12.05	75.33	19.25	5.64	100.22	75.11
Sheepshead (Diplodus probatocephalus)	48	11.90	74.38	24.02	3.93	102.33	72.05
Do	250	14.81	92.56	3.16	6.36	102.08	90.48
Do (average of 2 specimens)		13.36	83.47	13.59	5.14	102.20	81.27
Red bass (Sciæna ocellata)	270	14.65	91.56	2.89	6.67	101.12	90.44
Kingfish (Menticirrus nebulosus)	252	14.57	91.08	4.53	5.68	101.29	89.79
Weakfish (Cynoscion regale)	273	13.54	84.63	11.37	5.64	101.64	82.99
Blackfish (Hiatula onitis)	38	13.42	83.88	12.20	5.54	101.62	82.26
Do	205	15.12	94.52	2.95	3.48	100.95	93.57
Do	244	14.86	92.88	3.05	5.05	100.98	91.90
Do	269	14.07	87.94	6.69	6.30	100.93	87.01
Do (average of 4 specimens)		14.37	89.81	6.22	5.09	101.12	88.69
Hake (Phycis chuss)	113	14.56	91.00	3.97	5.77	100.74	90.26
Cusk (Brosmius brosme)	110	15.10	94.38	0.94	4.98	100.30	94.08
Haddock (Gadus æglefinus)	16	15.08	94.25	0.85	5.82	100.92	93.33
Do	21	14.77	92.31	0.78	8.72	101.81	90.50
Do	229	14.97	93.56	1.82	6.78	102.16	91.40
Do	259	15.27	95.44	1.93	5.71	103.08	92.36
Do (average of 4 specimens)		15.02	93.89	1.34	6.76	101.99	91.90
Cod (Gadus morrhua)	3	15.00	93.75	1.66	7.62	103.03	90.72
Do	11	15.50	96.88	2.39	7.60	106.87	90.01
Do	206	15.20	95.00	1.54	7.22	103.76	91.24
Do	228	15.30	95.63	1.89	6.03	103.55	92.08
Do	243	15.10	94.38	2.89	6.95	104.22	90.16
Do (average of 5 specimens)		15.22	95.13	2.07	7.08	104.28	90.84
Tomcod (Gadus tomcod)	99	14.95	93.44	2.08	5.32	100.84	92.60
Pollock (Gadus virens)	81	14.41	90.06	3.23	6.45	99.74	90.32
Halibut (Hippoglossus hippoglossus)	1	13.46	84.06	10.59	5.53	100.18	83.88
Do	9	9.93	62.06	35.41	3.83	101.30	60.76
Do	211	13.67	85.43	11.95	3.81	101.19	84.24
Do (average of 3 specimens)		12.35	77.18	19.32	4.39	100.89	76.29
Turbot (Platysomatichthys hippoglossoides)	49	8.25	51.56	50.36	4.47	106.39	45.17
Common flounder (Paralichthys dentatus)	2	14.35	89.69	3.73	7.67	101.09	88.60
Do	22	14.14	88.38	5.18	8.63	102.19	86.19
Do (average of 2 specimens)		14.24	89.03	4.46	8.15	101.64	87.39
Winter flounder (Pleuronectes americanus)	253	14.86	92.88	2.85	7.68	103.41	89.47
Lamprey eel (Petromyzon marinus)	236	8.30	51.88	46.03	2.27	100.18	51.70
Skate (Raia)	247	16.29	101.82	7.81	6.38	116.01	85.81

TABLE 3.—*Composition of flesh of American fishes.*

Kind of fish.	Laboratory No. of specimen.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats. Ether extract.	Ash.	Nitrogen.	Protein. N × 6.25	Water + protein + fats + ash.
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Sturgeon (Acipenser sturio)	238	78.71	21.29	17.96	1.90	1.43	2.90	18.11	100.15
Small-mouthed red-horse (Moxostoma velatum)	258	78.56	21.44	17.90	2.35	1.19	2.88	17.99	100.09
Herring (Clupea harengus)	47	69.03	30.97	18.46	11.01	1.50	3.06	19.12	100.66
Alewife (Clupea vernalis)	5	75.92	24.08	18.80	3.82	1.46	3.04	19.00	100.20
Do	220	72.96	27.04	19.54	6.02	1.48	3.16	19.72	100.18
Do (average of 2 specimens)	....	74.44	25.56	19.17	4.92	1.47	3.10	19.36	100.19
Shad (Clupea sapidissima)	6	69.65	30.35	18.25	10.80	1.30	2.98	18.64	100.39
Do	10	65.25	34.75	19.68	13.59	1.48	3.18	19.89	100.21
Do	32	70.75	29.25	17.83	10.08	1.34	2.89	18.08	100.25
Do	212	71.04	28.96	17.83	10.23	.90	2.92	18.19	100.36
Do	221	71.98	28.02	19.98	6.51	1.53	3.21	20.10	100.12
Do	245	72.14	27.86	18.24	8.08	1.54	2.95	18.40	100.16
Do	249	73.56	26.44	18.05	7.03	1.36	2.92	18.27	100.22
Do (average of 7 specimens)	..	70.62	29.38	18.56	9.47	1.35	3.01	18.83	100.27
Smelt (Osmerus mordax)	23	80.16	19.84	15.90	1.94	2.00	2.64	16.52	100.62
Do	207	78.16	21.84	18.83	1.65	1.36	2.98	18.65	99.82
Do (average of 2 specimens)	....	79.16	20.84	17.37	1.79	1.68	2.81	17.59	100.22
Whitefish (Coregonus clupeiformis)	18	69.83	30.17	22.06	6.49	1.62	3.67	22.93	100.87
Cisco (Coregonus, sp. tullibee or artedi?)	111	76.15	23.85	19.12	3.48	1.25	3.08	19.26	100.14
California salmon (Oncorhynchus chouicha)	27	62.68	37.32	16.96	19.25	1.11	3.26	......	......
Do	233	64.53	35.47	17.96	16.50	1.01	2.97	18.56	100.60
Do (average of 2 specimens)	...	63.61	36.39	17.46	17.87	1.06	3.12	......	......
Salmon (Salmo salar)	14	67.15	32.85	19.17	12.47	1.21	3.15	19.63	100.46
Do (female)	77	63.41	36.59	20.04	14.99	1.56	3.46	21.66	101.62
Do do	78	65.08	34.92	20.12	13.34	1.46	3.39	21.19	101.07
Do do	279	61.37	38.63	24.23	13.04	1.36	3.95	24.72	100.49
Do (male)	280	61.03	38.97	24.45	13.07	1.45	3.96	24.77	100.32
Do (average of 5 specimens)	....	63.61	36.39	21.60	13.38	1.41	3.59	22.39	100.79
Spent salmon (Salmo salar) (male)	35	75.27	24.73	19.24	4.37	1.12	3.06	19.15	99.91
Do (female)	36	78.20	21.80	17.80	2.83	1.17	2.82	17.62	99.82
Do (average of 2 specimens)	....	76.74	23.26	18.52	3.60	1.14	2.94	18.39	99.87
Spent land-locked salmon (Salmo salar, subsp. sebago) (male)	40	77.88	22.12	16.84	4.01	1.27	2.59	16.18	99.34
Do (female)	41	79.20	20.80	17.65	1.95	1.20	2.76	17.24	99.59
Do (average of 2 specimens)	..	78.54	21.46	17.24	2.98	1.24	2.68	16.71	99.47
Lake trout (Salvelinus namaycush)	17	68.78	31.22	17.32	12.55	1.35	2.82	17.62	100.30
Do	255	69.50	30.50	19.12	10.21	1.17	3.11	19.42	100.30
Do (average of 2 specimens)	....	69.14	30.86	18.22	11.38	1.26	2.97	18.52	100.30
Brook trout (Salvelinus fontinalis)	24	77.54	22.46	18.45	2.61	1.42	2.98	18.60	100.17
Do	254	79.84	20.16	18.45	0.75	0.96	3.01	18.80	100.35
Do	256	75.78	24.22	20.03	2.94	1.25	3.25	20.30	100.27
Do (average of 3 specimens)	....	77.72	22.28	18.97	2.10	1.21	3.08	19.23	100.26
Pike (Esox lucius)	98	79.79	20.21	18.60	0.58	1.03	2.99	18.67	100.07
Pickerel (Esox reticulatus)	100	79.84	20.16	18.40	0.52	1.24	2.96	18.43	100.03
Do	224	79.52	20.48	18.88	0.49	1.11	3.04	19.02	100.14
Do (average of 2 specimens)	....	79.68	20.32	18.64	0.50	1.18	3.00	18.73	100.09
Muskellunge (Esox nobilior)	45	76.26	23.74	19.63	2.54	1.57	3.22	20.15	100.52
Eel, salt-water (Anguilla rostrata)	4	69.80	30.20	18.95	10.34	0.91	3.08	19.25	100.30
Do	217	73.40	26.60	17.61	7.88	1.11	2.84	17.75	100.14
Do (average of 2 specimens)	....	71.60	28.40	18.28	9.11	1.01	2.96	18.50	100.22
Mullet (Mugil albula)	126	74.87	25.13	19.32	4.64	1.17	3.12	19.48	100.16
Mackerel (Scomber scombrus)	8	78.67	21.33	18.13	2.20	1.00	2.92	18.29	100.16
Do	13	74.26	25.74	17.48	7.02	1.24	2.80	17.51	100.03
Do	30	74.14	25.86	17.57	6.99	1.30	2.91	18.18	100.61
Do	39	64.01	35.99	18.21	16.30	1.48	3.05	19.08	100.87
Do	230	73.68	26.32	19.25	5.86	1.21	3.12	19.50	100.25
Do	261	75.44	24.56	19.07	4.21	1.28	3.11	19.43	100.36
Do (average of 6 specimens)	...	73.37	26.63	18.26	7.09	1.28	2.99	18.66	100.38
Spanish mackerel (Cybium maculatum)	43	68.10	31.90	20.97	9.43	1.50	3.43	21.45	100.48
Pompano (Trachynotus carolinus)	234	67.38	32.62	18.15	13.51	0.96	2.94	18.35	100.20
Do	263	78.18	21.82	19.15	1.64	1.03	3.09	19.30	100.15
Do (average of 2 specimens)	...	72.78	27.22	18.65	7.57	1.00	3.02	18.83	100.18
Bluefish (Pomatomus saltatrix)	12	78.46	21.54	19.02	1.25	1.27	3.11	19.41	100.39
Butter-fish (Stromateus triacanthus)	90	70.02	29.98	17.81	11.03	1.14	2.88	17.99	100.18
Large-mouthed black bass (Micropterus salmoides)	53	78.61	21.39	19.24	0.96	1.19	3.11	19.44	100.20
Small-mouthed black bass (Micropterus dolomieu)	91	74.82	25.18	21.50	2.44	1.24	3.47	21.71	100.21
Yellow perch (Perca fluviatilis)	127	80.43	19.57	17.88	0.55	1.14	2.85	17.79	99.91
Do	208	78.07	21.93	19.47	1.12	1.34	3.15	19.69	100.22
Do (average of 2 specimens)	..	79.25	20.75	18.68	0.83	1.24	3.00	18.74	100.06

TABLE 3.—*Composition of flesh of American fishes*—Continued.

Kind of fish.	Laboratory No. of specimen.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats. Ether extract.	Ash.	Nitrogen.	Protein, N × 6.25	Water + protein + fats + ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Wall-eyed pike (Stizostedion vitreum)	52	79.74	20.26	18.42	0.47	1.37	2.97	18.58	100.16
Gray pike (Stizostedion canadense)	257	80.85	19.15	17.26	0.76	1.13	2.86	17.88	100.62
Striped bass (Roccus lineatus)	7	79.02	20.98	18.26	1.56	1.16	2.99	18.69	100.43
Do	19	79.63	20.37	16.87	2.14	1.36	2.73	17.06	100.19
Do	225	77.27	22.73	18.81	2.81	1.11	3.04	18.97	100.16
Do	237	75.76	24.24	19.33	3.64	1.27	3.13	19.54	100.21
Do	248	77.87	22.13	18.81	2.20	1.12	3.04	18.97	100.16
Do	260	76.65	23.35	17.82	4.61	0.92	2.88	17.98	100.16
Do (average of 6 specimens)	....	77.70	22.30	18.31	2.83	1.16	2.97	18.54	100.22
White perch (Roccus americanus)	44	75.64	24.36	17.63	5.62	1.11	2.87	17.95	100.32
Do	46	75.77	24.23	20.43	2.52	1.28	3.29	20.58	100.15
Do (average of 2 specimens)	....	75.71	24.29	19.03	4.07	1.19	3.08	19.27	100.24
Sea bass (Centropristis atrarius)	251	79.32	20.68	18.75	0.49	1.44	3.17	19.84	101.09
Grouper (Epinephelus morio)	114	79.95	20.05	18.41	0.48	1.16	2.98	18.63	100.22
Do	271	78.96	21.04	19.15	0.75	1.14	3.17	19.81	100.66
Do (average of 2 specimens)	....	79.45	20.55	18.80	0.60	1.15	3.04	19.25	100.40
Red snapper (Lutjanus blackfordi)	20	78.22	21.78	19.89	0.62	1.27	3.23	20.17	100.28
Do	26	77.34	22.66	19.39	1.94	1.33	3.16	19.75	100.36
Do	242	79.81	20.19	18.31	0.54	1.34	3.08	19.26	100.95
Do (average of 3 specimens)	....	78.46	21.54	19.20	1.03	1.31	3.16	19.73	100.53
Porgy (Diplodus argyrops)	15	79.68	20.32	17.46	1.46	1.40	2.79	17.44	99.98
Do	31	71.98	28.02	18.81	7.86	1.35	3.02	18.86	100.05
Do	262	73.31	26.69	19.29	6.01	1.39	3.11	19.43	100.14
Do (average of 3 specimens)	....	74.99	25.01	18.52	5.11	1.38	2.97	18.58	100.06
Sheepshead (Diplodus probatocephalus)	48	72.01	27.99	20.17	6.72	1.10	3.33	20.82	100.65
Do	250	79.08	20.92	18.93	0.66	1.33	3.10	19.36	100.43
Do (average of 2 specimens)	....	75.55	24.45	19.54	3.69	1.22	3.22	20.08	100.54
Red bass (Sciæna ocellata)	270	81.56	18.44	16.68	0.53	1.23	2.70	16.88	100.20
Kingfish (Menticirrus nebulosus)	252	79.21	20.79	18.66	0.95	1.18	3.03	18.94	100.28
Weakfish (Cynoscion regale)	273	78.97	21.03	17.45	2.39	1.19	2.85	17.80	100.35
Blackfish (Hiatula onitis)	38	76.95	23.05	18.96	2.81	1.28	3.09	19.33	100.37
Do	205	81.36	18.64	17.44	0.55	0.65	2.82	17.61	100.17
Do	244	79.64	20.36	18.71	0.62	1.03	3.03	18.91	100.20
Do	269	78.44	21.56	18.76	1.44	1.36	3.03	18.96	100.20
Do (average of 4 specimens)	....	79.10	20.90	18.47	1.35	1.08	2.99	18.71	100.24
Hake (Phycis chuss)	113	83.11	16.89	15.24	0.67	0.98	2.46	15.37	100.13
Cusk (Brosmius brosme)	110	82.01	17.99	16.92	0.17	0.90	2.72	17.00	100.08
Haddock (Gadus æglefinus)	16	80.30	19.70	18.38	0.17	1.15	2.97	18.58	100.20
Do	21	82.03	17.97	16.26	0.14	1.57	2.65	16.55	100.29
Do	229	82.56	17.44	15.94	0.32	1.18	2.61	16.32	100.38
Do	259	81.87	18.13	16.75	0.35	1.03	2.77	17.31	100.56
Do (average of 5 specimens)	....	81.69	18.31	16.83	0.25	1.23	2.75	17.19	100.36
Cod (Gadus morrhua)	3	83.48	16.52	14.97	0.28	1.27	2.48	15.49	100.52
Do	11	83.39	16.61	14.95	0.40	1.26	2.58	16.09	101.14
Do	206	80.71	19.29	17.59	0.30	1.40	2.93	18.32	100.73
Do	228	83.43	16.57	15.26	0.31	1.00	2.54	15.84	100.58
Do	243	82.20	17.80	16.08	0.51	1.21	2.69	16.80	100.72
Do (average of 5 specimens)	....	82.64	17.36	15.77	0.36	1.23	2.54	16.51	100.74
Tomcod (Gadus tomcod)	99	81.55	18.45	17.08	0.38	0.99	2.76	17.24	100.16
Pollock (Gadus virens)	81	76.02	23.98	21.65	0.78	1.55	3.46	21.60	99.95
Halibut (Hippoglossus hippoglossus)	1	79.15	20.85	17.49	2.21	1.15	2.80	17.53	100.04
Do	9	70.13	29.87	18.16	10.57	1.14	2.97	18.54	100.38
Do	211	76.97	23.03	19.40	2.75	0.88	3.15	19.68	100.28
Do (average of 3 specimens)	....	75.42	24.58	18.35	5.17	1.06	2.97	18.58	100.23
Turbot (Platysomatichthys hippoglossoides)	49	71.39	28.61	12.92	14.41	1.28	2.36	14.75	101.83
Common flounder (Paralichthys dentatus)	2	83.37	16.63	14.73	0.62	1.28	2.39	14.91	100.18
Do	22	85.04	14.96	12.90	0.77	1.29	2.12	13.22	100.32
Do (average of 2 specimens)	....	84.21	15.79	13.82	0.69	1.28	2.26	14.07	100.25
Winter flounder (Pleuronectes americanus)	253	84.35	15.65	14.01	0.44	1.20	2.33	14.53	100.52
Lamprey eel (Petromyzon marinus) ?	236	71.12	28.88	14.93	13.29	0.66	2.40	14.98	100.05
Skate (Raia sp. ?)	247	82.15	17.85	15.32	1.39	1.14	2.91	18.17	102.85

TABLE 4.—*Composition of water-free substance of flesh of American specimens of preserved fish.*

Kind of fish.	Laboratory No. of specimen.	Nitrogen.	Protein, N. × 6.25.	Fats. Ether extract.	Crude ash (including salt).	Protein (N × 6.25) + fats + ash.	Albuminoids, etc. (by difference).
DRIED.		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Desiccated cod, "evaporated fish" (Gadus morrhua)	79	14.72	92.00	2.24	9.78	104.02	87.98
SALTED.							
Mackerel (Scomber scombrus)	42	5.85	36.56	39.08	22.76	98.40	38.16
SALTED AND DRIED.							
Cod (Gadus morrhua)	34	8.58	53.63	0.53	53.82	107.98	45.65
Do	37	8.91	55.69	0.94	52.43	109.06	46.63
Cod, boned (Gadus morrhua)	25	9.20	57.50	0.71	50.72	108.93	48.57
Desiccated cod, boned and ground (Gadus morrhua)	80	13.04	81.50	5.54	13.40	100.44	81.06
SALTED, SMOKED, AND DRIED.							
Haddock (Gadus æglefinus)	88	13.58	84.88	0.62	13.10	98.60	86.28
Halibut (Hippoglossus hippoglossus)	28	6.04	37.75	31.90	31.01	100.66	37.09
Do	218	7.04	44.00	27.61	28.42	100.03	43.97
Herring (Clupea harengus)	33	9.03	56.44	24.18	20.15	100.77	55.67
CANNED.							
Mackerel (Scomber scombrus)	94	9.87	61.68	27.28	10.17	99.13	62.55
Salmon (Oncorhynchus chouicha)	29	9.87	61.69	32.40	5.24	99.33	62.36
Do	96	8.48	53.00	38.55	9.34	100.89	52.11
Do	241	7.34	45.88	50.62	4.15	100.65	45.23
Sardines (Clupea pilchardus)*	87	9.12	57.00	29.14	12.85	98.99	58.01
Tunny, "horse mackerel" (Orcynus secundi-dorsalis)	240	12.72	79.50	14.84	6.19	100.53	78.97
Salt mackerel (Scomber scombrus)	95	4.68	29.25	49.22	21.09	99.56	29.69
Do	219	5.08	31.75	44.05	24.53	100.33	31.42
Smoked haddock (Gadus æglefinus)	275	11.40	71.25	7.18	23.14	101.57	69.68

* This specimen was said to be from France, and properly belongs with the European specimens beyond, but was analyzed and is inserted with the American specimens.

TABLE 5.—*Composition of flesh of American specimens of preserved fish.*

Kind of fish.	Laboratory No. of specimen.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats. Ether extract.	Ash.†	Salt.†	Nitrogen.	Protein N × 6.25.	Water + protein (N × 6.25) + fats + ash + salt.
DRIED.		*Per ct*	*Per ct.*	*Per ct.*	*Per ct.*	*P. ct.*	*Per ct.*	*P. ct.*	*Per ct.*	*P. ct.*
Desiccated cod, "evaporated fish" (Gadus morrhua)*	79	15.25	81.87	74.56	1.90	5.41	2.88	12.48	77.97	103.41
SALTED.										
Mackerel (Scomber scombrus)	42	42.19	47.21	22.06	22.59	2.56	10.60	3.38	21.14	99.08
SALTED AND DRIED.										
Cod (Gadus morrhua.)	34	53.62	23.01	21.17	0.25	1.59	23.37	3.98	24.87	103.70
Do	37	53.54	23.75	21.67	0.44	1.64	22.71	4.14	25.86	104.19
Do. (average of 2 specimens)	....	53.58	23.38	21.42	0.34	1.62	23.04	4.06	25.37	103.95
Cod, boned, "boneless codfish" (Gadus morrhua)	25	54.35	24.17	22.18	0.32	1.67	21.48	4.20	26.25	104.07
Desiccated cod, boned and ground (Gadus morrhua)	80	11.65	81.75	71.62	4.89	5.24	6.60	11.52	72.02	100.40
SALTED, SMOKED, AND DRIED.										
Haddock (Gadus æglefinus)	88	72.56	25.38	23.68	0.17	1.53	2.06	3.73	23.29	99.61
Halibut (H. hippoglossus)	28	51.06	35.89	18.15	15.61	2.13	13.05	2.96	18.49	100.34
Do	218	47.70	39.43	23.00	14.44	1.99	12.87	3.68	23.01	100.01
Do. (average of 2 specimens)	...	49.38	37.66	20.57	15.03	2.06	12.96	3.32	20.75	100.18
Herring (Clupea harengus)	33	34.55	53.79	36.44	15.82	1.53	11.66	5.91	36.94	100.50
CANNED.										
Mackerel (Scomber scombrus)	94	68.18	29.89	19.91	8.68	1.30	1.93	3.14	19.63	99.72
Salmon (Oncorhynchus chouicha)	29	65.86	33.61	21.29	11.06	1.26	0.53	3.37	21.06	99.77
Do	96	62.23	35.58	19.69	14.55	1.34	2.19	3.20	20.02	100.33
Do	241	57.55	42.04	19.20	21.49	1.35	0.41	3.12	19.47	100.27
Do (average of 3 specimens)	...	61.88	37.08	20.06	15.70	1.32	1.04	3.23	20.18	100.12
Sardines (Clupea pilchardus)*	87	56.37	43.63	25.31	12.71	5.61	....	3.98	24.87	99.56
Tunny, "horse mackerel" (Orcynus secundi-dorsalis)	240	72.74	27.26	21.52	4.05	1.69	....	3.47	21.67	100.15
Salt mackerel (Scomber scombrus)	95	43.23	47.33	16.86	27.94	2.53	9.44	2.66	16.60	99.74
Do	219	43.62	45.22	17.71	24.84	2.67	11.16	2.86	17.90	100.19
Do. (average of 2 specimens)	...	43.43	46.27	17.28	26.39	2.60	10.30	2.76	17.35	99.97
Smoked haddock (Gadus æglefinus)	275	68.73	25.68	21.78	2.25	1.65	5.59	3.58	22.29	100.51

* French, but analyzed with American specimens.

† Computed by assuming the ash to bear the same ratio to albuminoids, etc. Fat as in the fresh fish, the excess of mineral matter being taken as salt.

TABLE 6.—*Composition of water-free substance of flesh of specimens of American fishes. Proximate ingredients as directly determined.*

Kind of fish.	Laboratory No. of specimen.	Extractive matters. Cold-water extract, not coagulated.	Albumen, coagulated from cold-water extract.	Gelatin. Hot-water extract.	Insoluble protein.	Fats. Ether extract.	Ash.	Total.
FRESH FISH.		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Black bass (Micropterus salmoides)	53	10.49*	9.54	14.48*	....	4.47	5.57	....
Blackfish (Hiatula onitis)	38	7.46*	11.32	15.79*	51.00*	12.20	5.54	103.31
Common flounder (Paralichthys dentatus)	22	12.77†	6.51	24.07†	....	5.18	8.63	....
Haddock (Gadus æglefinus)	21	6.18†	7.89	16.36†	65.06	0.78	8.72	104.99
Herring (Clupea harengus)	47	4.51*	5.23	9.46*	....	35.55	4.83	....
Muskellunge (Esox nobilior)	45	9.55*	6.95	10.20*	56.71*	10.70	6.63	100.74
Mackerel (Scomber scombrus)	30	8.61*	7.27	5.74*	47.37†	27.04	5.02	101.05
Spanish mackerel (Cybium maculatum)	43	6.96*	3.92	9.22*	....	29.56	4.71	....
White perch (Roccus americanus)	44	6.76*	7.35	13.39*	....	23.07	4.56	....
Do	46	8.88*	9.78	11.04*	51.47*	10.42	5.27	96.86
Do (average of 2 specimens)	....	7.82*	8.57	12.22*	....	16.75	4.92	....
Pike perch (Stizostedion vitreum)	52	13.14*	5.87	16.98*	52.15*	2.31	6.75	97.20
Porgy (Diplodus argyrops)	31	6.35*	10.64	7.41*	44.40†	28.04	4.81	101.65
Red snapper (Lutjanus blackfordi)	20	8.38†	7.30	16.83†	60.84	2.85	5.82	102.02
Do	26	8.16†	8.12	12.75†	56.09	8.58	5.86	99.56
Do (average of 2 specimens)	....	8.27†	7.71	14.79†	58.46	5.72	5.84	100.79
California salmon (Oncorhynchus chouicha)	27	4.85†	4.21	4.74†	32.02	51.59	2.98	100.39
Shad (Clupea sapidissima)	32	6.68*	6.57	6.63*	43.60†	34.50	4.58	102.56
Sheepshead (Diplodus probatocephalus)	48	5.11*	7.11	11.98*	....	24.02	3.93	....
Smelt (Osmerus mordax)	23	16.23†	3.02	25.07†	37.50	9.76	10.08	101.66
Brook trout (Salvelinus fontinalis)	24	11.44†	8.01	9.88†	55.74	11.61	6.33	103.01
Turbot (Platysomatichthys hippoglosoides)	49	7.04*	0.42	12.89*	28.14*	50.36	4.47	103.32
SPENT FISH.								
Salmon (Salmo salar) (male)	35	9.18*	4.69	9.66*	53.09*	17.66	4.51	98.79
Do (female)	36	6.27*	4.59	13.92*	....	12.98	5.36	....
Do (average of 2 specimens)	....	7.73*	4.64	11.79	....	15.32	4.94	....
Land-locked salmon (Salmo salar, subsp. sebago) (male)	40	9.18†	2.94	8.88*	......	18.12	5.76	....
Land-locked salmon (Salmo salar, subsp. sebago) (female)	41	10.56†	5.14	10.58*	......	9.36	5.76	....
Do (average of 2 specimens)	....	9.87†	4.04	9.73*	....	13.74	5.76	....
PRESERVED FISH.								
Salt mackerel (Scomber scombrus)	42	6.17*	0.50	2.91*	26.81*	39.08	22.76	98.23
Salt cod (Gadus morrhua)	34	3.26*	1.07	10.38*	32.67*	0.53	53.82	101.73
Do	37	2.50*	2.07	7.28*	36.92*	0.94	52.43	102.14
Do (average of 2 specimens)	....	2.88	1.57	8.83	34.80	0.73	53.12	101.94
Boned cod (Gadus morrhua)	25	7.01†	1.84	6.62†	32.81	0.71	50.72	99.71
Smoked halibut (Hippoglossus hippoglossus)	28	5.60†	1.51	3.23*	26.57†	31.90	31.01	†99.82
Smoked herring (Clupea harengus)	33	13.04*	0.48	7.84*	33.14†	24.18	20.15	†98.83
Canned salmon (Oncorhynchus chouicha)	29	14.21†	....	5.27†	42.44†	32.40	5.24	†99.56

* Ash and fat free. † Ash-free.

TABLE 7.—*Composition of flesh of specimens of American fishes. Proximate ingredients as directly determined.*

Kind of fish.	Laboratory No. of specimen.	Water.	Extractive matters. Cold water extract, not coagulated.	Albumen, coagulated from cold-water extract.	Gelatin. Hot-water extract.	Insoluble protein.	Fats. Ether extract.	Ash.	Total.
FRESH FISH.									
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Black bass (Micropterus salmoides)	53	78.61	2.24*	2.04	3.10*	......	0.96	1.19	......
Blackfish (Hiatula onitis)	38	76.95	1.72*	2.61	3.64*	11.76*	2.81	1.28	100.77
Common flounder (Paralichthys dentatus)	22	85.04	1.91†	0.98	3.60†	......	0.77	1.29	......
Haddock (Gadus æglefinus)	21	82.03	1.11†	1.42	2.94†	11.70	0.14	1.57	100.91
Herring (Clupea harengus)	47	69.03	1.40*	1.62	2.93*	......	11.01	1.50	......
Muskellunge (Esox nobilior)	45	76.26	2.27*	1.65	2.40*	13.46*	2.54	1.57	100.15
Mackerel (Scomber scombrus)	30	74.14	2.22*	1.88	1.48*	12.25†	6.99	1.30	100.26
Spanish mackerel (Cybium maculatum)	43	68.10	2.22*	1.25	2.94*	......	9.43	1.50	......
White perch (Roccus americanus)	44	75.64	1.65*	1.79	3.27*	......	5.62	1.11	......
Do	46	75.77	2.22*	2.37	2.68*	12.47*	2.52	1.28	99.31
Do (average of 2 specimens)	....	75.71	1.94*	2.08	2.98*	......	4.07	1.20	......
Pike perch (Stizostedion vitreum)	52	79.74	2.66*	1.19	3.44*	10.57*	0.47	1.37	99.44
Porgy (Diplodus argyrops)	31	71.98	1.78*	2.98	2.07*	12.44†	7.86	1.35	100.46
Red snapper (Lutjanus blackfordi)	20	78.22	1.81†	1.59	3.65†	13.25	0.62	1.27	100.41
Do	26	77.34	1.85†	1.84	2.89†	12.71	1.94	1.33	99.90
Do (average of 2 specimens)	....	77.78	1.83†	1.72	3.27†	12.98	1.28	1.30	100.15
California salmon (Oncorhynchus chouicha)	27	62.68	1.81†	1.57	1.77†	11.95	19.25	1.11	100.14
Shad (Clupea sapidissima)	32	70.75	1.92*	1.92	1.93*	12.74†	10.08	1.34	100.68
Sheepshead (Diplodus probatocephalus)	48	72.01	1.44*	1.99	3.36*	......	6.72	1.10	......
Smelt (Osmerus mordax)	23	80.16	3.22†	0.60	4.97†	7.44	1.94	2.00	100.33
Brook trout (Salvelinus fontinalis)	24	77.54	2.57†	1.80	2.22†	12.52	2.61	1.42	100.68
Turbot (Platysomatichthys hippoglossoides)	49	71.39	2.01*	0.12	3.69*	8.05*	14.41	1.28	100.95
SPENT FISH.									
Salmon (Salmo salar) (male)	35	75.27	2.27*	1.16	2.39*	13.13*	4.37	1.12	99.71
Do (female)	36	78.20	1.37*	1.00	3.03*	......	2.83	1.17	......
Do (average of 2 specimens)	....	76.74	1.82	1.08	2.71	......	3.60	1.15	......
Land-locked salmon (salmo salar, subsp. sebago) (male)	40	77.88	2.03†	0.65	1.97*	......	4.01	1.27	......
Do (female)	41	79.20	2.20†	1.07	2.20*	......	1.95	1.20	......
Do (average of 2 specimens)	....	78.54	2.11†	0.86	2.09*	......	2.98	1.24	......
PRESERVED FISH									
Salt mackerel (Scomber scombrus)	42	42.19	3.57*	0.29	1.68*	15.49*	22.59	13.16	98.97
Salt cod (Gadus morrhua)	34	53.62	1.51*	0.50	4.79*	15.15*	0.25	24.96	100.78
Do	37	53.54	1.16*	0.96	3.38*	17.17*	0.44	24.35	101.00
Do (average of 2 specimens)	....	53.58	1.34	0.73	4.08	16.16	0.35	24.65	100.89
Boned cod (Gadus morrhua)	25	54.35	3.20†	0.84	3.02†	14.98	0.32	23.15	99.86
Smoked halibut (Hippoglossus hippoglossus)	28	57.06	2.74†	0.74	1.58*	13.01†	15.61	15.18	99.92
Smoked herring (Clupea harengus)	33	34.55	8.53*	0.32	5.13*	21.69†	15.82	13.19	99.23
Canned salmon (Oncorhynchus chouicha)	29	65.86	4.85†	......	1.80†	14.49†	11.06	1.79	99.85

* Ash and fat free. † Ash free.

TABLE 8.—*Percentages of phosphoric acid, sulphuric acid, and chlorine in flesh of specimens of American fishes.*

Kind of fish.	Laboratory No. of specimen.	In water-free substance. Phosphoric acid. Total phosphorus calculated as P_2O_5.	In water-free substance. Phosphoric acid. Total phosphorus calculated as PO_4.	In water-free substance. Sulphuric acid. Total sulphur calculated as SO_3.	In water-free substance. Sulphuric acid. Total sulphur calculated as SO_4.	In water-free substance. Chlorine.	In fresh substance. Phosphoric acid. Total phosphorus calculated as P_2O_5.	In fresh substance. Phosphoric acid. Total phosphorus calculated as PO_4.	In fresh substance. Sulphuric acid. Total sulphur calculated as SO_3.	In fresh substance. Sulphuric acid. Total sulphur calculated as SO_4.	In fresh substance. Chlorine.
FRESH FISH.		*P. ct.*	*P. ct.*	*P. ct*	*P. ct*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct*	*P. ct*	*P. ct.*
Alewife (Clupea vernalis)	5	2.06	2.76	....	....	.....	0.50	0.67	....	....	.....
Black bass (Micropterus salmoides)	53	2.04	2.73	4.14	4.97	.....	0.44	0.59	0.89	1.07	.....
Striped bass (Roccus lineatus)	7	2.51	3.36	...	....	.....	0.53	0.71	--	...	.....
Do	19	2.16	2.89	2.28	2.73	.....	0.44	0.59	0.46	0.55	.....
Do (average of 2 specimens)	....	2.34	3.13	....	....	.....	0.48	0.64	....	....	.....
Blackfish (Hiatula onitis)	38	2.24	3.01	1.97	2.36	1.03	0.52	0.70	0.46	0.55	0.23
Bluefish (Pomatomus saltatrix)	12	2.93	3.92	....	....	.....	0.63	0.84	....	....	.....
Cod (Gadus morrhua)	3	2.19	2.93	....	....	.....	0.36	0.48	....	....	.....
Do	11	3.18	4.26	....	....	.....	0.53	0.71	....	....	.....
Do (average of 2 specimens)	....	2.69	3.60	....	....	.....	0.45	0.60	....	....	.....
Eel, salt-water (Anguilla rostrata)	4	1.70	2.28	....	....	.....	0.51	0.68	....	....	.....
Flounder (Paralichthys dentatus)	2	1.86	2.49	2.23	2.68	.....	0.31	0.41	0.38	0.46	.....
Do	22	2.70	3.62	3.10	3.72	.....	0.40	0.54	0.46	0.55	.....
Do (average of 2 specimens)		2.28	3.06	2.67	3.20	.....	0.36	0.48	0.42	0.50	.....
Haddock (Gadus æglefinus)	16	2.43	3.26	....	....	.....	0.48	0.64	....	....	.....
Do	21	2.54	3.40	2.26	2.71	.....	0.45	0.60	0.40	0.48	.....
Do (average of 2 specimens)	....	2.49	3.34	....	....	.....	0.47	0.63	...	....	.....
Halibut (Hippoglossus hippoglossus)	1	2.11	2.83	2.11	2.53	.....	0.44	0.59	0.44	0.53	.....
Do	9	1.51	2.02	....	....	.....	0.43	0.58	....	....	.....
Do (average of 2 specimens)	....	1.81	2.43	....	....	.....	0.44	0.59	....	..	.....
Herring (Clupea harengus)	47	1.77	2.37	1.77	2.12	.....	0.55	0.74	0.55	0.66	.....
Muskellunge (Esox nobilior)	45	2.21	2.96	1.55	1.86	.....	0.52	0.70	0.37	0.44	.....
Mackerel (Scomber scombrus)	8	2.26	3.03	....	....	.....	0.47	0.63	....	....	.....
Do	13	2.43	3.26	...	...	.....	0.63	0.84	....	....	.....
Do	30	2.16	2.89	1.68	2.02	.....	0.56	0.75	0.43	0.52	.....
Do	39	1.60	2.14	1.42	1.70	0.68	0.58	0.78	0.51	0.61	0.24
Do (average of 4 specimens)	....	2.11	2.83	1.55	1.86	....	0.56	0.75	0.47	0.56	.....
Spanish mackerel (Cybium maculatum)	43	1.88	2.52	1.81	2.17	.....	0.60	0.80	0.58	0.70	.....
White perch (Roccus americanus)	44	1.46	1.96	2.54	3.05	.....	0.36	0.48	0.62	0.74	.....
Do	46	2.13	2.85	2.80	3.36	.....	0.52	0.70	0.68	0.82	.....
Do (average of 2 specimens)	....	1.79	2.40	2.67	3.20	.....	0.44	0.59	0.65	0.78	.....
Pike perch (Stizostedion vitreum)	52	2.24	3.00	4.43	5.32	.....	0.45	0.60	0.90	1.08	.....
Porgy (Diplodus argyrops)	15	3.04	4.07	....	...	.....	0.62	0.83	....	....	.....
Do	31	1.98	2.65	1.84	2.21	.....	0.56	0.75	0.52	0.62	.....
Do (average of 2 specimens)	....	2.51	3.36	..	....	.....	0.59	0.79	....	....	.....
Red-snapper (Lutjanus blackfordi)	20	2.15	2.88	2.19	2.63	.....	0.47	0.63	0.47	0.56	.....
Do	26	2.10	2.81	2.06	2.47	.....	0.48	0.64	0.46	0.55	.....
Do (average of 2 specimens)	....	2.13	2.85	2.13	2.56	.....	0.47	0.63	0.47	0.56	.....
Salmon (Salmo salar)	14	1.79	2.40	....	....	.....	0.59	0.79	....	....	.....
California salmon (Oncorhynchus chouicha)	27	1.86	2.49	1.14	1.37	.....	0.69	0.92	0.43	0.52	.....
Spent salmon (Salmo salar) (male)	35	1.89	2.53	1.58	1.90	0.74	0.47	0.63	0.39	0.47	0.18
Do (female)	36	2.20	2.95	1.45	1.74	0.85	0.48	0.64	0.32	0.38	0.18
Do (average of 2 specimens)	....	2.05	2.75	1.52	1.82	0.80	0.48	0.64	0.36	0.43	0.18
Spent salmon, land-locked (Salmo salar, subsp. sebago.) (male)	40	2.31	3.10	1.77	2.12	0.95	0.51	0.68	0.39	0.47	0.21
Do (female)	41	2.43	3.26	1.98	2.38	0.93	0.51	0.68	0.41	0.49	0.19
Do (average of 2 specimens)	....	2.37	3.18	1.88	2.26	0.94	0.51	0.68	0.40	0.48	0.20
Shad (Clupea sapidissima)	10	1.94	2.60	....	....	.....	0.67	0.90	....	....	....
Do	32	1.76	2.36	1.78	2.14	0.74	0.52	0.70	0.52	0.62	0.22
Do (average of 2 specimens)	....	1.85	2.48	....	..	.....	0.60	0.80	....	....	.....
Sheepshead (Diplodus probatocephalus)	48	1.62	2.17	1.71	2.05	.....	0.45	0.60	0.48	0.58	.....
Smelt (Osmerus mordax)	23	4.10	5.49	2.79	2.35	.....	0.81	1.08	0.55	0.66	.....
Turbot (Platysomatichthys hippoglossoides)	49	1.66	2.22	1.12	1.34	.....	0.48	0.64	0.32	0.38	.....
Lake trout (Salvelinus namaycush)	17	1.80	2.41	1.94	2.33	.....	0.56	0.75	0.62	0.74	.....
Brook trout (Salvelinus fontinalis)	24	2.72	3.64	2.13	2.56	.....	0.61	0.82	0.48	0.58	.....
Whitefish (Coregonus clupeiformis)	18	2.35	3.15	1.36	1.63	.....	0.71	0.95	0.41	0.49	.....
PRESERVED FISH.											
Salt mackerel (Scomber scombrus)	42	0.61	0.82	1.06	1.27	.....	0.35	0.47	0.61	0.73	.....
Salt cod (Gadus morrhua)	34	0.61	0.82	1.56	1.87	25.66	0.28	0.37	0.72	0.86	11.90
Do	37	0.48	0.64	1.61	1.93	25.71	0.22	0.29	0.75	0.90	11.94
Do (average of 2 specimens)	..	0.55	0.74	1.59	1.91	25.69	0.25	0.34	0.74	0.89	11.92
Boned cod (Gadus morrhua)	25	0.79	1.06	1.48	1.78	24.51	0.36	0.48	0.68	0.82	11.19
Smoked halibut (H. hippoglossus)	28	0.95	1.27	0.89	1.07	17.69	0.46	0.62	0.44	0.53	8.66
Smoked herring (Clupea harengus)	33	1.28	1.72	1.89	2.27	11.01	0.84	1.12	1.24	1.49	7.21
Canned salmon (Oncorhynchus chouicha)	29	1.77	2.37	1.27	1.52	.....	0.60	0.80	0.43	0.52	.....

TABLE 9.—*Composition of American fishes. Specimens as received for analysis, including both flesh (edible portion) and refuse.*

Names of fish and portions analyzed.	Laboratory No. of specimen.	In whole or dressed fish as taken for analysis.						
		Refuse: Entrails, bones, skin, etc.	Edible portion.					
			Edible portion (flesh).	Water.	Water-free substance (nutrients).	Nutrients.		
						Albuminoids (by difference).	Fats.	Mineral matters.
FRESH FISH.								
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. c.*
Sturgeon (Acipenser sturio), section of anterior part of body	238	14.4	85.6	67.4	18.2	15.4	1.6	1.2
Small-mouthed red-horse (Moxostoma velatum), entrails removed	258	52.5	47.5	37.3	10.2	8.5	1.1	0.6
Herring (Clupea harengus), whole	47	46.0	54.0	37.3	16.7	10.0	5.9	0.8
Alewife (Clupea vernalis), whole	5	49.5	50.5	38.3	12.2	9.5	1.9	0.8
Do	220	49.4	50.6	36.9	13.7	9.9	3.0	0.8
Do (average of 2 specimens)	....	49.5	50.5	37.5	13.0	9.7	2.5	0.8
Shad (Clupea sapidissima), whole	6	49.3	50.7	35.3	15.4	9.2	5.5	0.7
Do	10	46.4	53.6	35.0	18.6	10.5	7.3	0.8
Do	32	45.9	54.1	38.3	15.8	9.6	5.5	0.7
Do	212	44.4	55.6	39.5	16.1	9.9	5.7	0.5
Do	221	53.2	46.8	33.7	13.1	9.3	3.1	0.7
Do	245	52.7	47.3	34.1	13.2	8.6	3.8	0.8
Do	249	58.8	41.2	30.3	10.9	7.4	2.9	0.6
Do (maximum of 7 specimens)	....	58.8	55.6	39.5	18.6	10.5	7.3	0.8
Do (minimum of 7 specimens)	....	44.4	41.2	30.3	10.9	7.4	2.9	0.6
Do (average of 7 specimens)	....	50.1	49.9	35.2	14.7	9.2	4.8	0.7
Smelt (Osmerus mordax), whole	23	34.8	65.2	52.3	12.9	10.4	1.2	1.3
Do	207	49.0	51.0	39.9	11.1	9.6	0.8	0.7
Do (average of 2 specimens)	....	41.9	58.1	46.1	12.0	10.0	1.0	1.0
Whitefish (Coregonus clupeiformis), whole	18	53.5	46.5	32.5	14.0	10.3	3.0	0.7
Cisco (Coregonus, sp. tullibee or artedi?), whole	111	42.7	57.3	43.6	13.7	11.0	2.0	0.7
California salmon (Oncorhynchus chouicha), sections of anterior part of body	27	0.0	100.0	62.7	37.3	17.0	19.2	1.1
Do	233	10.3	89.7	57.9	31.8	16.1	14.8	0.9
Do (average of 2 specimens)	....	5.2	94.8	60.3	34.5	16.5	17.0	1.0
Salmon (Salmo salar), female, whole	77	33.5	66.5	42.2	24.3	13.3	10.0	1.0
Do	78	30.8	69.2	45.0	24.2	13.9	9.3	1.0
Do	279	37.5	62.5	38.3	24.2	15.2	8.1	0.9
Salmon (Salmo salar), male, whole	280	39.5	60.5	36.9	23.6	14.8	7.9	0.9
Do (maximum of 4 specimens)	....	39.5	69.2	45.0	24.3	15.2	10.0	1.0
Do (minimum of 4 specimens)	....	30.8	60.2	36.9	23.6	13.3	7.9	0.9
Do (average of 4 specimens)	....	35.3	64.7	40.6	24.1	14.3	8.8	1.0
Salmon (Salmo salar), entrails removed	14	23.8	76.2	51.2	25.0	14.6	9.5	0.9
Lake trout, "Mackinaw trout" (Salvelinus namaycush), whole	17	56.3	43.7	30.0	13.7	7.7	5.4	0.6
Lake trout, "Mackinaw trout" (Salvelinus namaycush), entrails removed	255	35.2	64.8	45.0	19.8	12.4	6.6	0.8
Brook trout (Salvelinus fontinalis), whole, cultivated	24	50.1	49.9	38.7	11.2	9.2	1.3	0.7
Do	254	45.2	54.8	43.8	11.0	10.1	0.4	0.5
Do	256	49.1	50.9	38.6	12.3	10.2	1.5	0.6
Do (average of 3 specimens)	....	48.1	51.9	40.4	11.5	9.8	1.1	0.6
Pickerel (Esox reticulatus), whole	100	45.4	54.6	43.6	11.0	10.0	0.3	0.7
Do	224	48.7	51.3	40.8	10.5	9.7	0.2	0.6
Do (average of 2 specimens)	....	47.1	52.9	42.2	10.7	9.8	0.2	0.7
Pike (Esox lucius), whole	98	42.7	57.3	45.7	11.6	10.7	0.3	0.6
Muskellunge (Esox nobilior), whole	45	49.2	50.8	38.7	12.1	10.0	1.3	0.8
Eel, salt-water (Anguilla rostrata), skin, head, and entrails removed	4	21.4	78.6	54.9	23.7	14.9	8.1	0.7
Do	217	19.0	81.0	59.4	21.6	14.3	6.4	0.9
Do (average of 2 specimens)	....	20.2	79.8	57.2	22.6	14.6	7.2	0.8
Mullet (Mugil albula), whole	126	57.9	42.1	31.5	10.6	8.1	2.0	0.5
Mackerel (Scomber scombrus), whole	8	38.3	61.7	48.5	13.2	11.2	1.4	0.6
Do	13	51.8	48.2	35.8	12.4	8.4	3.4	0.6
Do	30	48.9	51.1	37.9	13.2	8.9	3.6	0.7
Do	39	33.8	66.2	42.4	23.8	12.1	10.7	1.0
Do	261	50.4	49.6	37.4	12.2	9.5	2.1	0.6
Do (maximum of 5 specimens)	....	57.9	66.2	48.5	23.8	12.1	10.7	1.0
Do (minimum of 5 specimens)	....	33.8	48.2	35.8	12.2	8.4	1.4	0.6
Do (average of 5 specimens)	....	44.6	55.4	40.4	15.0	10.0	4.3	0.7
Mackerel (Scomber scombrus), entrails removed	230	40.7	59.3	43.7	15.6	11.4	3.5	0.7
Spanish mackerel (Cybium maculatum), whole	43	34.6	65.4	44.5	20.9	13.7	6.2	1.0

TABLE 9.—*Composition of American fishes. Specimens as received for analysis, including both flesh (edible portion) and refuse*—Continued.

Names of fish and portions analyzed.	Laboratory No. of specimen.	In whole or dressed fish as taken for analysis. Refuse: Entrails, bones, skin, etc.	Edible portion (flesh).	Edible portion. Water.	Water-free substance (nutrients).	Nutrients. Albuminoids (by difference).	Fats.	Mineral matters.
FRESH FISH—Continued.		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P.c.*
Pompano (Trachynotus carolinus), whole	234	42.4	57.6	38.8	18.8	10.5	7.8	0.5
Do	263	48.6	51.4	40.2	11.2	9.9	0.8	0.5
Do (average of 2 specimens)	...	45.5	54.5	39.5	15.0	10.2	4.3	0.5
Bluefish (Pomatomus saltatrix), entrails removed	12	48.6	51.4	40.3	11.1	9.8	0.6	0.7
Butter-fish (Stromateus triacanthus), whole	90	42.8	57.2	40.1	17.1	10.2	6.3	0.6
Large-mouthed black bass (Micropterus salmoides), whole	53	56.0	44.0	34.6	9.4	8.5	0.4	0.5
Small-mouthed black bass (Micropterus dolomieu), whole	91	53.6	46.4	34.7	11.7	10.0	1.1	0.6
Yellow perch (Perca fluviatilis), whole	127	62.7	37.3	30.0	7.3	6.7	0.2	0.4
Yellow perch (Perca fluviatilis), head, entrails, fins, and tail removed	208	35.1	64.9	50.7	14.2	12.6	0.7	0.9
Wall-eyed pike (Stizostedion vitreum), whole	52	57.2	42.8	34.1	8.7	7.9	0.2	0.6
Gray pike (Stizostedion canadense), whole	257	63.2	36.8	29.7	7.1	6.4	0.3	0.4
Striped bass (Roccus lineatus), whole	7	56.7	43.3	34.2	9.1	7.9	0.7	0.5
Do	19	56.9	43.1	34.4	8.7	7.2	0.9	0.6
Do	225	48.6	51.4	39.7	11.7	9.7	1.4	0.6
Do	237	57.1	42.9	32.5	10.4	8.3	1.6	0.5
Do	248	55.4	44.6	34.7	9.9	8.4	1.0	0.5
Do (maximum of 5 specimens)	..	57.1	51.4	39.7	11.7	9.7	1.6	0.6
Do (minimum of 5 specimens)	.	48.6	42.9	32.5	8.7	7.2	0.7	0.5
Do (average of 5 specimens)		54.9	45.1	35.1	10.0	8.3	1.1	0.6
Striped bass (Roccus lineatus), entrails removed	260	51.2	48.8	37.4	11.4	8.7	2.2	0.5
White perch (Roccus americanus), whole	44	63.2	36.8	27.8	9.0	6.5	2.1	0.4
Do	45	61.8	38.2	28.9	9.3	7.8	1.0	0.5
Do (average of 2 specimens)	..	62.5	37.5	28.4	9.1	7.2	1.5	0.4
Sea bass (Centropristris atrarius), whole	251	56.1	43.9	34.8	9.1	8.3	0.2	0.6
Red grouper (Epinephelus morio), entrails removed		55.8	44.2	35.3	8.9	8.2	0.2	0.5
Do	271	55.9	44.1	34.8	9.3	8.5	0.3	0.5
Do (average of 2 specimens)	...	55.9	44.1	35.0	9.1	8.4	0.2	0.5
Red snapper (Lutjanus blackfordi):								
Whole	20	40.0	60.0	46.9	13.1	11.9	0.4	0.8
Entrails removed	26	52.5	47.5	36.8	10.7	9.2	0.9	0.6
Entrails and gills removed	242	45.3	54.7	43.7	11.0	10.0	0.3	0.7
Dressed (average of 2 specimens)	..	48.9	51.1	40.3	10.8	9.6	0.6	0.6
Porgy (Diplodus argyrops), whole	15	65.1	34.9	27.8	7.1	6.1	0.5	0.5
Do	31	57.3	42.7	30.7	12.0	8.0	3.4	0.6
Do	262	57.6	42.4	31.1	11.3	8.2	2.5	0.6
Do (maximum of 3 specimens)	....	65.1	42.7	31.1	12.0	8.2	3.4	0.6
Do (minimum of 3 specimens)	....	57.3	34.9	27.8	7.1	6.1	0.5	0.5
Do (average of 3 specimens)	....	60.0	40.0	29.9	10.1	7.4	2.1	0.6
Sheepshead (Diplodus probatocephalus), entrails removed	48	56.5	43.5	31.3	12.2	8.8	2.9	0.5
Do	250	66.0	34.0	26.9	7.1	6.4	0.2	0.5
Red bass (Sciæna ocellata), whole	270	63.5	36.5	29.8	6.7	6.1	0.2	0.4
Kingfish (Menticirrus nebulosus), whole	252	56.6	43.4	34.4	9.0	8.1	0.4	0.5
Weakfish (Cynosion regale), whole	273	51.9	48.1	38.0	10.1	8.4	1.1	0.6
Blackfish (Hiatula onitis):								
Whole	38	56.2	43.8	33.7	10.1	8.3	1.2	0.6
Do	205	64.1	35.9	29.2	6.7	6.3	0.2	0.2
Entrails removed	244	57.8	42.2	33.5	8.7	7.9	0.4	0.4
Do	269	53.6	46.4	36.4	10.0	8.7	0.7	0.6
Whole (average of 2 specimens)	....	60.1	39.9	31.5	8.4	7.3	0.7	0.4
Dressed (average of 2 specimens)		55.7	44.3	35.0	9.3	8.3	0.5	0.5
Hake (Phycis chuss), entrails removed	113	52.5	47.5	39.5	8.0	7.2	0.3	0.5
Cusk (Brosmius brosme), entrails removed	110	40.3	59.7	49.0	10.7	10.1	0.1	0.5
Haddock (Gadus æglefinus) entrails removed	16	51.4	48.6	39.0	9.6	8.9	0.1	0.6
Do	21	51.6	48.4	39.7	8.7	7.8	0.1	0.8
Do	229	48.0	52.0	42.9	9.1	8.3	0.2	0.6
Do	259	52.9	47.1	38.5	8.6	7.9	0.2	0.5
Do (maximum of 4 specimens)	...	52.9	52.0	42.9	9.6	8.9	0.2	0.8
Do (minimum of 4 specimens)	...	48.0	47.1	38.5	8.6	7.8	0.1	0.5
Do (average of 4 specimens)	...	51.0	49.0	40.0	9.0	8.2	0.2	0.6
Cod (Gadus morrhua), head and entrails removed	3	33.7	66.3	55.3	11.0	9.9	0.2	0.9

TABLE 9.—*Composition of American fishes. Specimens as received for analysis, including both flesh (edible portion) and refuse*—Continued.

Names of fish and portions analyzed.	Salt.	Laboratory No. of specimen.	In whole or dressed fish as taken for analysis. Refuse: Entrails, bones, skin, etc.	Edible portion (flesh).	Edible portion. Water.	Water-free substance (nutrients).	Nutrients. Albuminoids (by difference).	Fats.	Mineral matters.
FRESH FISH—Continued.			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P.c.*
Cod (Gadus morrhua), head and entrails removed		11	30.6	69.4	57.9	11.5	10.4	0.3	0.8
Do		228	25.5	74.5	62.1	12.4	11.4	0.2	0.8
Cod (Gadus morrhua), whole		206	56.5	43.5	35.1	8.4	7.7	0.1	0.6
Do		243	48.5	51.5	42.3	9.2	8.3	0.3	0.6
Cod (Gadus morrhua), dressed (average of 3 specimens)		....	29.9	70.1	58.5	11.6	10.6	0.2	0.8
Cod (Gadus morrhua), whole (average of 2 specimens)		...	52.5	47.5	38.7	8.8	8.0	0.2	0.6
Tomcod (Gadus tomcod), whole		99	59.9	40.1	32.7	7.4	6.8	0.2	0.4
Pollock (Gadus virens), head and entrails removed		81	28.5	71.5	54.3	17.2	15.5	0.6	1.1
Halibut (Hippoglossus hippoglossus):									
Posterior part of body, lean		1	23.1	76.9	60.9	16.0	13.4	1.7	0.9
Section of body fatter than No. 1		9	11.2	88.8	62.3	26.5	16.1	9.4	1.0
Sections from different parts of body		211	18.7	81.3	62.6	18.7	15.8	2.2	0.7
Average of 3 specimens		....	17.7	82.3	61.9	20.4	15.1	4.4	0.9
Turbot (Platysomatichthys hippoglossoides), whole		49	47.7	52.3	37.3	15.0	6.8	7.5	0.7
Common flounder (Paralichthys dentatus), entrails removed		2	57.0	43.0	35.8	7.2	6.3	0.3	0.6
Common flounder (Paralichthys dentatus), whole		22	66.8	33.2	27.2	6.0	5.2	0.3	0.5
Winter flounder (Pleuronectes americanus), whole		253	56.2	43.8	37.0	6.8	6.1	0.2	0.5
Lamprey eel (Petromyzon marinus), whole		236	45.8	54.2	38.5	15.7	8.1	7.2	0.4
Skate (Raia sp.), left lobe of body		247	51.0	49.0	40.2	8.8	7.5	0.7	0.6
SPENT FISH.									
Salmon (Salmo salar), male, whole		35	43.8	56.2	42.3	13.9	10.8	2.5	0.6
Salmon (Salmo salar), female, whole		36	43.5	56.5	44.2	12.3	10.0	1.6	0.7
Do (average of 2 specimens)		....	43.6	56.4	43.3	13.1	10.4	2.1	0.6
Salmon, land-locked (Salmo salar, subsp. sebago), male, whole		....	48.4	51.6	40.2	11.4	8.7	2.1	0.6
Salmon, land-locked (Salmo salar, subsp. sebago), female, whole		41	46.2	53.8	42.6	11.2	9.5	1.0	0.7
Do (average of 2 specimens)		....	47.3	52.7	41.4	11.3	9.1	1.6	0.6
ROE.									
Shad roe, from shad No. 245		246	0.0	100.0	71.2	28.8	23.4	3.8	1.6
PRESERVED FISH.									
DRIED.	*Pr. ct.*								
Cod (Gadus morrhua,) flesh desiccated and ground	2.9	79	0.0	97.1	15.2	81.9	74.6	1.9	5.4
SALTED.									
Mackerel (Scomber scombrus), "No. 1 mackerel"	7.1	42	33.3	59.6	28.1	31.5	14.7	15.1	1.7
SALTED AND DRIED.									
Salt cod (Gadus morrhua), "channel fish"	17.3	34	25.5	57.2	40.0	17.2	15.7	0.3	1.2
Salt cod (Gadus morrhua), "boat fish"	17.2	37	24.3	58.5	40.5	18.0	16.4	0.4	1.2
Do (average of 2 specimens)	17.2	....	24.9	57.9	40.3	17.6	16.0	0.4	1.2
Salt cod (Gadus morrhua), boned "boneless codfish"	19.1	25	0.0	80.9	54.4	26.5	22.1	0.3	4.1
Salt cod (Gadus morrhua), flesh desiccated and ground)	6.6	80	0.0	93.4	11.7	81.7	71.6	4.9	5.2
SALTED, SMOKED AND DRIED.									
Smoked herring (Clupea harengus)	6.5	33	44.4	49.1	19.2	29.9	20.2	8.8	0.9
Smoked haddock, "Findon haddie" (Gadus æglefinus)	1.4	88	32.2	66.4	49.2	17.2	16.1	0.1	1.0
Smoked halibut (Hippoglossus hippoglossus)	12.0	28	8.0	80.0	47.0	33.0	16.7	14.4	1.9
Do	12.1	218	5.9	82.0	44.9	37.1	21.6	13.6	1.9
Do (average of 2 specimens)	12.1	....	6.9	81.0	46.0	35.0	19.1	14.0	1.9
CANNED.									
Sardines (Clupea pilchardus)	0.0	87	5.0	95.0	53.6	41.4	24.0	12.1	5.3
Salmon (Oncorhynchus chouicha)	0.4	29	11.7	87.9	58.2	29.7	18.8	9.8	1.1

TABLE 9.—*Composition of American fishes. Specimens as received for analysis, including both flesh (edible portion) and refuse*—Continued.

Names of fish and portions analyzed.	Salt.	Laboratory No. of specimen.	In whole or dressed fish as taken for analysis. Refuse: Entrails, bones, skin, etc.	Edible portion (flesh).	Edible portion. Water.	Water-free substance (nutrients).	Nutrients. Albuminoids (by difference).	Fats.	Mineral matters.
PRESERVED FISH—Continued.			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. c.*
Salmon (Oncorhynchus chouicha)	2.2	96	0.0	97.8	62.2	35.6	19.7	14.6	1.3
Do	0.4	241	0.0	99.6	56.6	42.0	19.2	21.5	1.3
Do (average of 3 specimens)	1.0	....	3.9	95.1	59.3	35.8	19.3	15.3	1.2
Mackerel (Scomber scombrus)	1.9	94	0.0	98.1	68.2	29.9	19.9	8.7	1.3
Salt mackerel (Scomber scombrus), "No. 2 mackerel"	7.9	95	17.0	75.1	35.8	39.3	14.0	23.2	2.1
Do	8.7	219	22.4	68.9	33.8	35.1	13.7	19.3	2.1
Do (average of 2 specimens)	8.3	....	19.7	72.0	34.8	37.2	13.8	21.3	2.1
Tunny, "Horse mackerel" (Orcynus secundi-dorsalis)	0.0	240	0.0	100.0	72.7	27.3	21.5	4.1	1.7
Smoked haddock (Gadus æglefinus)	5.6	275	0.0	94.4	68.7	25.7	21.8	2.3	1.6

5. PROTEIN IN THE FLESH OF FISHES.

ERRORS INVOLVED IN THE COMMON METHOD OF ESTIMATION.

In the tables in division 3 of this section, which give the results of analyses of specimens of the flesh of fishes, the percentages of protein as estimated by multiplying the nitrogen by the factor 6.25, and those of "albuminoids, etc." (actual nitrogenous substances), as estimated by difference [100—(ether extract + ash) = "albuminoids, etc."], are both given. In the tables which recapitulate the analyses these figures for "albuminoids by difference" are taken for the nitrogenous matters.

It will be interesting to observe the differences between results obtained by estimating the nitrogenous substance by these two methods (see remarks on "Nitrogen, Protein, etc.," under Methods of Analysis, above). If we leave the carbohydrates out of account, assume the ash to represent the mineral matters, and take ether extract as representing the fats, but as including no nitrogenized fats, then the figures for "albuminoids, etc., by difference" will represent exactly the amount of nitrogenous substance (albuminoids, gelatinoids, nitrogenous extractives, and nitrogenized fats). Of course, these assumptions are not absolutely correct. The flesh contains a minute quantity of carbohydrates (including all non-nitrogenous organic substances other than fats); the ash is not the exact measure of the mineral matters, and the ether extract does not exactly represent the neutral fats. But the errors involved are small, and until better methods of analysis are devised

and brought into current use, "albuminoids, etc., by difference" will be the closest approach to the actual nitrogenous substance.

The current method of estimating the nitrogenous material is by multiplying the nitrogen by 6.25. To this product, various terms, as albuminoids, proteids, and protein, are applied. If the figures for "albuminoids, etc., by difference" were the exact measure of the nitrogenous substance, the difference between them and the product of $N \times 6.25$ would be the error in computing protein in this latter way. In Table 2 the ash + ether extract + "albuminoids by difference" = 100; and the ash + ether extract + protein ($N \times 6.25$) = a quantity varying more or less from 100. On the assumption that the "albuminoids by difference" represent the actual nitrogenous substance, the variations from 100 in the latter figures represent the error in calculating protein by multiplying N by 6.25.

Of course, the correct determination of actual nitrogenous substance involves numerous other questions in addition to those here suggested, and first of all the chemical and physiological distinctions between the different nitrogenous compounds. But for the present purpose it will suffice to take the "albuminoids, etc., by difference" as the measure of the nitrogenous material.

The tabular statements which follow give the sum of ash + fat + protein ($N \times 6.25$) in water-free substance, and of water + ash + fat + protein ($N \times 6.25$) in flesh, of the specimens of fishes in Tables 2 and 3, and of prepared fish in Tables 4 and 5. For the water-free substance the range of the figures is from 97.01 to 116.01, but in the flesh (leaving the preserved fish out of account) the range is only from 99.34 to 102.85, or, omitting the skate, to 101.14.* The only cases in which the sum is below 99 in the water-free substance of the fresh flesh are those of the spent salmon. In these, both nitrogenous substance and fat had been reduced during the spawning season. The only ones above 101 in the flesh are two specimens of fat salmon, one each of sea bass and turbot, several of cod, and one of skate. It is clear that the use of either of the figures for protein, $N \times 6.25$, or "albuminoids, etc., by difference," for the total nitrogenous substance in the flesh, will involve no very serious error except in the last named cases.

The figures for protein in sea bass, turbot, cod, and especially skate, are a little surprising. The question naturally suggests itself whether there may not be errors in the analyses. The analytical details show that this explanation is extremely improbable. All the nitrogenous determinations in the specimens of cod gave large figures. Two determinations in the specimens of skate gave respectively 16.28 and 16.29 per cent. in the water-free substance. These figures are so large that a third determination was made, with 16.30 as the result.

* In our analyses of the flesh of fishes or other animals, when this sum has varied much from 100, we have repeated the work to make sure of its correctness.

In brief, while the error involved in estimating the total nitrogenous substance by multiplying the nitrogen by the factor 6.25 in the usual way, is, when viewed from the exact scientific standpoint, very considerable in many cases, it is seldom large enough to be of great practical importance. The exceptional cases, however, demand further study.

Sum of protein ($N \times 6.25$), *ether extract, ash, and water in the flesh of specimens of American fishes.*

Lab. No.	Name.	Protein + ether extract + ash in water-free substance.	Protein + ether extract + ash + water in flesh.	Averages. Protein + ether extract + ash in water-free substance.	Averages. Protein + ether extract + ash + water in flesh.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
40	Spent land-locked salmon	97.01	99.34	97.50	99.47
41	....do	98.00	99.59		
36	Spent salmon	99.15	99.82	99.38	99.87
35	....do	99.61	99.91		
81	Pollock	99.74	99.95		
236	Lamprey eel	100.18	100.05		
15	Porgy	99.94	99.98	100.22	100.06
31	....do	100.16	100.05		
262	....do	100.57	100.14		
127	Yellow perch	99.55	99.91	100.29	100.13
208	....do	101.04	100.22		
110	Cusk	100.30	100.08		
98	Pike pickerel	100.32	100.07		
100	Pickerel	100.15	100.03	100.43	100.09
224	....do	100.72	100.14		
258	Small-mouthed red-horse	100.48	100.09		
111	Cisco	100.59	100.14		
126	Mullet	100.61	100.16		
90	Butter-fish	100.62	100.18		
234	Pompano	100.60	100.20	100.65	100.18
263	....do	100.70	100.15		
220	Alewife	100.70	100.18	100.73	100.19
5	....do	100.77	100.20		
113	Hake	100.74	100.13		
52	Pike perch, wall-eyed pike	100.75	100.16		
217	Salt-water eel	100.53	100.14	100.77	100.22
4	....do	101.02	100.30		
91	Small-mouthed black bass	100.81	100.21		
238	Sturgeon	100.81	100.15		
99	Tomcod	100.84	100.16		
1	Halibut	100.18	100.04	100.89	100.23
211	....do	101.19	100.28		
9	do	101.30	100.38		
221	Shad	100.45	100.12	100.91	100.27
245	...do	100.68	100.16		
10	....do	100.74	100.21		
249	....do	100.87	100.22		
32	....do	100.96	100.25		
212	....do	101.28	100.36		
6	....do	101.37	100.39		
53	Large-mouthed black bass	100.92	100.20		
46	White perch	100.63	100.15	100.97	100.24
44	....do	101.32	100.32		
17	Lake trout	100.97	100.30	100.99	100.30
255	....do	101.01	100.30		
260	Striped bass	100.67	100.16	101.00	100.23
248	....do	100.73	100.16		
225	....do	100.77	100.16		
237	....do	100.88	100.21		
19	....do	100.96	100.24		
7	....do	102.03	100.43		
269	Blackfish	100.93	100.20	101.12	100.24
205	....do	100.95	100.17		
244	....do	100.98	100.20		
38	....do	101.62	100.37		
270	Red bass	101.12	100.20		
207	Smelt	99.17	99.82	101.13	100.22
23	....do	103.09	100.62		
24	Brook trout	100.75	100.17	101.17	100.26
256	....do	101.03	100.27		
254	....do	101.72	100.35		
252	Kingfish	101.29	100.28		

Sum of protein ($N \times 6.25$), *ether extract, ash, and water in the flesh of specimens of American fishes*—Continued.

Lab. No.	Name.	Protein + ether extract + ash in water-free substance.	Protein + ether extract + ash + water in flesh.	Averages. Protein + ether extract + ash in water-free substance.	Averages. Protein + ether extract + ash + water in flesh.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
13	Mackerel	100.15	100.03		
8	....do	100.73	100.16		
230	....do	100.94	100.21	101.34	100.37
261	....do	101.46	100.36		
30	....do	102.37	100.61		
39	....do	102.39	100.87		
43	Spanish mackerel	101.52	100.48		
273	Weakfish	101.64	100.35		
2	Common flounder	101.09	100.18	101.64	100.25
22	....do	102.19	100.32		
233	California salmon	101.67	100.60		
12	Bluefish	101.83	100.39		
16	Haddock	100.92	100.20		
21	....do	101.81	100.32	101.99	100.37
229	....do	102.16	100.38		
259	....do	103.08	100.56		
114	Grouper	101.18	100.17	102.06	100.40
271	....do	102.94	100.62		
47	Herring	102.07	100.66		
280	Salmon	100.82	100.32		
14	....do	101.10	100.46		
279	....do	101.27	100.49	102.14	100.79
78	....do	103.08	101.07		
77	....do	104.43	101.62		
45	Muskellunge	102.20	100.52		
250	Sheepshead	102.08	100.43	102.20	100.54
48	....do	102.33	100.65		
20	Red snapper	101.30	100.28		
26	....do	101.69	100.36	102.50	100.53
242	....do	104.53	100.95		
18	Whitefish	102.87	100.87		
257	Pike perch, Gray pike	103.23	100.62		
253	Winter flounder	103.41	100.52		
3	Cod	103.03	100.52		
228	....do	103.55	100.58		
206	....do	103.76	100.73	104.28	100.74
243	....do	104.22	100.72		
11	....do	106.87	101.14		
251	Sea bass	105.04	101.09		
49	Turbot	106.39	101.83		
247	Skate	116.01	102.85		
	PRESERVED FISH.				
79	Desiccated cod, flesh desiccated and ground, dried.	104.02	103.41		
42	Mackerel, salted	98.40	99.08		
34	Cod, salted and dried	107.98	103.70	108.57	103.95
37	....do	100.06	104.19		
88	Haddock, salted, smoked, and dried	98.60	99.61		
218	Halibut, salted, smoked, and dried	100.03	100.01	100.35	100.18
28	....do	109.66	100.34		
33	Herring	100.77	100.50		
87	Sardines, canned	98.99	99.56		
94	Mackerel, canned	99.13	99.72		
95	Salt mackerel, canned	99.56	99.74	99.95	99.97
219	....do	100.33	100.19		
29	Salmon, canned	99.33	99.77		
241	....do	100.65	100.27	100.29	100.12
96	....do	100.89	100.33		
240	Tunny, "Horse mackerel," canned	100.53	100.15		
275	Smoked haddock, canned	101.57	100.51		

6. CLASSIFICATION OF SPECIMENS OF AMERICAN FISHES BY THEIR CHEMICAL COMPOSITION.

On the basis of the figures of Tables 1, 3, and 9 I have attempted a classification of the specimens of American fishes analyzed, by their content of (1) flesh, (2) water-free substance in flesh, and (3) water and fats. With the following figures the classifications will need no further explanation. Where more than one specimen was analyzed the averages of the analyses are used. Of course, a satisfactory classification would require many more analyses. Nevertheless, these figures may be assumed to give a tolerably fair idea of the relative composition of the fish, or at least an approximation that may serve until more complete data are obtained. Accordingly, the exact order of the species in each of the groups in the tabular arrangements which follow must be regarded as by no means fixed, since further analyses would very likely give averages varying more or less from the results here tabulated.

In the following table the species of which entire specimens of fish were received for analysis, *i. e.*, specimens from which no portion had been removed before weighing and preparing for analysis, are arranged in order from those with the largest to those with the smallest proportions of flesh. The data are from Tables 1 and 9.

Classification of fishes by percentages of flesh, chiefly muscular tissue, in entire body.

Kind of fish.	No. of specimens analyzed.	Flesh.	Kinds of fish.	No. of specimens analyzed.	Flesh.
Containing 60 per cent. or over of flesh.			*Containing between 50 and 40 per cent. of flesh.*		*Per ct.*
		Per ct.	Shad	7	49.9
Spanish mackerel	1	65.4	Weakfish	1	48.1
Salmon	4	64.7	Cod	2	47.5
Red snapper	1	60.0	Whitefish	1	46.5
			Small-mouthed black bass	1	46.4
			Striped bass	5	45.1
Containing between 60 and 50 per cent. of flesh.			Large-mouthed black bass	1	44.0
			Sea bass	1	43.9
			Winter flounder	1	43.8
Smelt	2	58.1	Lake trout, "Mackinaw trout"	1	43.7
Pike (pickerel)	1	57.3	Kingfish	1	43.4
Cisco	1	57.3	Pike perch, "wall-eyed pike"	1	42.8
Butter-fish	1	57.2	Mullet	1	42.1
Spent salmon	2	56.4	Tomcod	1	40.1
Mackerel	5	55.4	Porgy	3	40.0
Pompano	2	54.5	*Containing between 40 and 30 per cent. of flesh.*		
Lamprey eel	1	54.2			
Herring	1	54.0	Blackfish	2	39.9
Pickerel	2	52.9	White perch	2	37.5
Spent land-locked salmon	2	52.7	Yellow perch	1	37.3
Turbot	1	52.3	Pike perch, "gray pike"	1	36.8
Brook trout	3	51.9	Red bass	1	36.5
Muskellunge	1	50.8	Sheepshead	1	34.0
Alewife	2	50.5	Common flounder	1	33.2

In the next tabular arrangement, compiled from Table 3, the species are grouped by the percentages of water-free substance in the flesh, from those with the most to those with the least water-free substance. Of course, those with the most water-free substance have the least water, and *vice versa;* hence the first in the list have the lowest percentages of water, and the last are the most watery.

Classification of fishes by proportions of water-free substance in the flesh of specimens analyzed.

Kinds of fish.	No. of specimens analyzed.	Water-free substance.
Containing over 30 per cent. of water-free substance.		*Per ct.*
California salmon	2	36.4
Salmon	5	36.4
Spanish mackerel	1	31.9
Herring	1	31.0
Lake trout	2	30.9
Whitefish	1	30.2
Containing from 30 to 25 per cent. of water-free substance.		
Butter-fish	1	30.0
Shad	7	29.4
Lamprey eel	1	28.9
Turbot	1	28.6
Salt-water eel	2	28.4
Pompano	2	27.2
Mackerel	6	26.6
Alewife	2	25.6
Small-mouthed black bass	1	25.2
Mullet	1	25.1
Porgy	3	25.0
Containing between 25 and 20 per cent. of water-free substance.		
Halibut	3	24.6
Sheepshead	2	24.5
White perch	2	24.3
Pollock	1	24.0
Cisco	1	23.9
Muskellunge	1	23.7
Spent salmon	2	23.3
Striped bass	6	22.3
Containing between 25 and 30 p. ct. of water-free substance—Cont'd.		*Per ct.*
Brook trout	3	22.3
Bluefish	1	21.5
Red snapper	3	21.5
Spent land-locked salmon	2	21.5
Small-mouthed red-horse	1	21.4
Large-mouthed black bass	1	21.4
Sturgeon	1	21.3
Weakfish	1	21.0
Blackfish	4	20.9
Smelt	2	20.8
Kingfish	1	20.8
Yellow perch	2	20.8
Sea bass	1	20.7
Grouper	2	20.6
Pickerel	2	20.3
Pike perch, "wall-eyed pike"	1	20.3
Pike (pickerel?)	1	20.2
Containing between 20 and 15 per cent. of water-free substance.		
Pike perch, gray pike	1	19.2
Tomcod	1	18.5
Red bass	1	18.4
Haddock	4	18.3
Cusk	1	18.0
Skate	1	17.9
Cod	5	17.4
Hake	1	16.9
Common flounder	2	15.8
Winter flounder	1	15.7

The next tabular arrangement, likewise from Table 3, gives a grouping of the species by the proportions of fat (ether extract) in the specimens analyzed. They are arranged in order from those with the most to those with the least fats in the flesh. The proportions of water are also given to illustrate the principle, to be discussed in another place, that as a rule the percentage of water in the muscular tissue diminishes as that of fat increases, and *vice versa.* In general the fattest species have the most water-free substance.

Classification of fishes by proportions of fat in the flesh of specimens analyzed.

Kinds of fish.	No. of specimens analyzed.	Water.	Fats.	Kinds of fish.	No. of specimens analyzed.	Water.	Fats.
Containing over 5 per cent. of fats.		*Per ct.*	*P. ct.*	*Containing less than 2, the majority less than 1 per cent. of fats.*		*Per ct.*	*P. ct.*
California salmon	2	63.6	17.9	Sturgeon	1	78.7	1.9
Turbot	1	71.4	14.4	Smelt	2	79.2	1.8
Salmon	5	63.6	13.4	Skate	1	82.2	1.4
Lamprey eel	1	71.1	13.3	Blackfish	4	79.1	1.4
Lake trout	2	69.1	11.4	Bluefish	1	78.5	1.3
Butter-fish	1	70.0	11.0	Red snapper	3	78.5	1.0
Herring	1	69.0	11.0	Large-mouthed black bass	1	78.6	1.0
Shad	7	70.6	9.5	Kingfish	1	79.2	1.0
Spanish mackerel	1	68.1	9.4	Pollock	1	76.0	0.8
Salt-water eel	2	71.6	9.1	Yellow perch	2	79.3	0.8
Pompano	2	72.8	7.6	Pike perch, Gray pike	1	80.9	0.8
Mackerel	6	73.4	7.1	Hake	1	83.1	0.7
Whitefish	1	69.8	6.5	Common flounder	2	84.2	0.7
Halibut	3	75.4	5.2	Grouper	2	79.4	0.6
Porgy	3	75.0	5.1	Pike (pickerel?)	1	79.8	0.6
Containing between 5 and 2 per cent. of fats.				Sea bass	1	79.3	0.5
				Pike perch, Wall-eyed pike	1	79.7	0.5
Alewife	2	74.4	4.9	Pickerel	2	79.7	0.5
Mullet	1	74.9	4.6	Red bass	1	81.6	0.5
White perch	2	75.7	4.1	Tomcod	1	81.6	0.4
Sheepshead	2	75.6	3.7	Cod	5	82.6	0.4
Spent salmon	2	76.7	3.6	Winter flounder	1	84.4	0.4
Cisco	1	76.2	3.5	Haddock	4	81.7	0.3
Spent land-locked salmon	2	78.5	3.0	Cusk	1	82.0	0.2
Striped bass	6	77.7	2.8				
Muskellunge	1	76.3	2.5				
Small-mouthed black bass	1	74.8	2.4				
Weakfish	1	79.0	2.4				
Small-mouthed red-horse	1	78.6	2.4				
Brook trout	3	77.7	2.1				

Comparison of the above groupings with the classification by families as practiced by ichthyologists shows no very definite connection between the two. For that matter there is perhaps no reason to expect any such connection.

SECTION B.—EUROPEAN FISHES.

1.—LIST OF NAMES OF EUROPEAN FISHES, OF WHICH ANALYSES ARE HERE COLLATED.

In attempting to collate such European analyses of the flesh of fish as have been performed by methods now in vogue and are consequently capable of fair comparison with the analyses of American fishes reported, I have found the following:

(1) *Fishes analyzed by Payen.*—These include analyses of 18 specimens of 17 species and are especially worthy of note as being the first series of analyses of any considerable importance made by modern methods.

(2) *Analyses by König.*—Professor König and his assistants have likewise published a series of analyses, 9 specimens of 8 or 9 species.

(3) *Analyses by Buckland.*—These are only 2 in number, of 2 species.

(4) *Analyses by Almén.*—These include 18 specimens of 10 or 11 species, and constituted at the time of their publication the largest

contribution made to the knowledge of the chemical composition of the flesh of fish.

(5) *Analyses by Kostytscheff.*—These include 31 specimens of some 24 species. A considerable number of these, however, are of the prepared flesh or other parts of fish, so that, although their practical importance is very considerable, they contribute less to our knowledge of the actual composition of the tissues in their natural conditions than the number would indicate. The same remarks apply, though in less degree, to the analyses of Almén, König, and Payen.

(6) I also append the results of analyses of 2 specimens of European haddock made by myself in connection with the investigation on the digestibility of the flesh of fish reported beyond.

The above include all the analyses of the flesh of fish made by methods now current, which I had succeeded in finding when the present report was prepared. The following have since come to hand, but too late to be included in the tabular recapitulations.

(7) *Analyses by Popoff.*—These are reported by Kostytscheff and include 8 specimens of fresh and salt fish and 2 of roe of apparently 4 species.

(8) *Analyses by Sempolowski.*—Ten specimens were analyzed including 1 each of 7 species of fish, 1 of a crab, 1 of starfish, and 1 of oysters. They were chiefly for the purpose of learning the value of the materials for fertilizers and are of less interest here. The main results, however, are quoted beyond.

In the reports of Almén and of Kostytscheff Latin names are given. In the other reports, some of the names are those of species so common and well known as to leave little or no doubt, while other names are local or such as are applied to two or more species. Where the Latin names are not given by the analyst and are inserted by myself they are inclosed in brackets. In some cases the Latin names were kindly furnished by Prof. D. S. Jordan. These are indicated by "J" outside the brackets. Especially doubtful cases are indicated in the list of names by omission of the specific names or by an interrogation point.

The numbers prefixed to the names in the subjoined lists are those employed to designate the specimens in the tabular statements and discussions beyond.

NAMES OF EUROPEAN FISHES.

Fishes analyzed by Payen.—The French names herewith are those given by Payen, *Précis des Substances Alimentaires*, 4th ed., 1865, pp. 45 and 488. The German names are taken from a report of Payen's analyses in Dingler, *Polyt. Journal*, 134 (1854), 385. The analyses to follow are from the same sources.

No. I. Raie, Rochem, Skate, [*Raia*, sp.].
No. II. Anguille de mer (Congre), Meeraal, Conger eel, Conger [*vulgaris* ?].
No. III. Morue salée, Gesalzener Stockfisch, Stockfish, Salt codfish (?).
No. IV. Sardines à l'huile, Sardines, [*Clupea*, sp.].

No. V. Harengs salés, Gesalzener Häring, Salt herring, [*Clupea harengus*].
No. VI. Harengs frais, Frischer Häring, Herring, [*Clupea harengus*].
No. VII. Merlau, Merlan, Whiting, [*Gadus harengus**].
No. VIII. Maquereau, Makrele, Mackerel, [*Scomber scombrus*].
No. IX. Sole, Meerzunge, Sole, *Pleuronectes solea*, [*Solea vulgaris*]
No. X. Limande, Glahrke, Dab, *Pleuronectes limanda*
No. XI. Saumon, Lachs, Salmon, *Salmo salar*.
No. XII. Brochet, Hecht, Pike, *Esox lucius*.
No. XIII. Carpe, Karpfen, Carp, [*Cyprinus carpio*], J.
No. XIV. Barbillon, Bartfischen, Barbel (?), [*Barbus vulgaris* (?)].
No. XV. Gardon, Plotze (?), Roach (?), [*Leuciscus* sp.].
No. XVI. Goujons, Grundling, Gudgeon, *Gobio* sp.†
No. XVII. Ahlettes, Uklei, (Kleiner) Weissfisch Bleak, [*Alburnus lucidus* ?].
No. XVIII. Anguille, Aal, Eel, [*Anguilla* sp.].

Fishes analyzed by König.—The following list of fishes analyzed by König and assistants, and the analyses beyond, are taken from König *Nahrungsmittel*, 2d ed., I, 16–18. The German names are König's.

No. XIX. Hecht, Pike, [*Esox lucius*].
No. XX. Shellfisch, Haddock (?), [*Gadus* sp.].
No. XXI. Häring, Salt Herring, [*Clupea harengus* (?)].
No. XXII. Lachs, Salmon, [*Salmo salar*].
No. XXIII. Sardellen, Anchovies (?), [*Engraulis encrasicholus* (?)].
No. XXIV. Stockfisch (Getrockneter Schellfisch), Cod or Ling (?), [*Gadus* sp.].
No. XXV. Bücklinge, Smoked herring (?), [*Clupea harengus* (?)].
No. XXVI. Sprotten, Sprat, [*Clupea sprattus*]. J.
No. XXVII. Neunaugen, Lamprey eel, [*Petromyzon* sp.].

I have marked haddock (Schellfisch), No. XVIII, as doubtful, though it may be less so than some of the others. Schellfisch is given in the books which I have consulted as the name for haddock (*M. aeglefinus*) in distinction from Dorsch, cod (*G. morrhua*), and is so used in common parlance, as I have observed, in different parts of Germany. But the plural is used generically for edible fishes of the genus, and in No. XXII of König's list it seems to me probable that it is intended to apply to cod or some other species of the same genus. The herring I suppose to be *C. harengus*.

Fishes analyzed by Buckland.—The following German names are, like the analyses, given by Konig,‡ for fishes reported§ as analyzed by F. Buckland. I have not seen Buckland's original account of the analyses, but there would seem to be little doubt that the ordinary salmon and herring are intended.

No. XXVIII. Lachs, Salmon, [*Salmo salar* (?)].
No. XXIX. Häring, Herring, [*Clupea harengus* (?)].

* *Gadus aeglefinus !* Payen, loc. cit., p. 45.

† Payen, loc. cit., speaks of the goujon as *Gobio cyprinus*, a species which I do not find in Günther's catalogue.

‡ In the Archiv f. Pharmacie, 1874, 203.

§ Nahrungsmittel, I, 16.

Fishes analyzed by Almén.—The subjoined list, with the analyses which follow, is copied from a monograph by Almén.* The English names, it will be noticed, are the last. The names in brackets are inserted by myself.

No. XXX. Aal, *Murœna anguilla* Lin., Al, Anguille, Eel.
No. XXXI. Makrele, *Scomber scombrus*, Lin., Makrill, Macquereau vulgaire.
No. XXXII. Lachs, *Salmo salar* Lin. Lax, Saumon, Salmon.
No. XXXIII. Stromling, *Clupea harengus* var. *membras* Lin., Stromming, Hareng commun petit, Little Herring, [Whitebait (?)].
No. XXXIV. Scholle, *Pleuronectes platessa* Lin., Flundra, Plie commune, Plaice.
No. XXXV. Barsch, *Perca fluviatilis* Lin., Aborre, Perche, Perch.
No. XXXVI. Dorsch, *Gadus callarias* Lin., [*Gadus morrhua*, Günther], Torsk, Morue proprement dite, Common cod.
No. XXXVII. Hecht, *Esox lucius* Lin., Gädda, Brochet commun, Pike.
No. XXXVIII. Gesalzener Häring, *Clupea harengus* Lin., Salt sill, Hareng commun, Herring.
No. XXXIX. Gesalzener fette Makrele, *Scomber scombrus* Lin., Salt Fet-Makrill, Maquereau vulgaire, Mackerel.
No. XL. Gesalzener Lachs, *Salmo salar* Lin., Salt Lax, Saumon, Salmon.
No. XLI. Kabeljau oder gesalzener Leng, *Gadus molva* Lin., Kabeljo eller salted Langa, Lingue, Ling.
No. XLII. Gesalzener Strömling, *Clupea harengus* var. *membras* Lin., Salt Stromming, Hareng commun petit, Little Herring, [Whitebait (?)].
No. XLIII. Stockfisch. *Gadus virens* Lin., Grasej, Stockfisk, Merlan noir, Codfish. [The *Gadus virens* is Pollock or Coalfish.]
No. XLIV. Fischmehl, *Gadus*, Fiskmjol, Morue, Cod.
No. XLV. Leng, *Gadus molva*, Lin., Spillanga eller torkad Langa Molva, Ling.

Fishes analyzed by Kostytscheff.—The following list of names and the accompanying analyses of Russian fishes analyzed by Professor Kostytscheff, are taken (with the analyses which follow) from a tabular statement (in English) exhibited at the International Fisheries Exhibition in London, in 1883. The explanatory names in brackets were kindly supplied by Professor Jordan. The names and analyses have also been compared with an English translation, made at the instance of the U. S. Fish Commission, of an article by Professor Kostytscheff in the Russian "Journal of Rural Economy and Forestry," vol. CXLIV, part II.

No. XLVI. Sigg, *Coregonus baerii*. [A kind of whitefish or lavaret].
No. XLVII. Pike perch, *Lucioperca sandra*, [Sandre, Stizostedion sandra].
No. XLVIII. Codfish, *Gadus morrhua*.
No. XLIX. Carp, *Cyprinus carpio*.
No. L. Pike, *Esox lucius*.
No. LI. Crucian carp, *Carassius vulgaris*.
No. LII. *Gadus navaga*, Russian cod, [*Pleurogadus navaga*].
No. LIII. Smelt, *Osmerus eperlanus*.
No. LIV. Salmon, *Salmo salar*.
No. LV. Salmon-trout, *Salmo trutta*.
No. LVI. *Clupea harengus* var. *membras*, [Common herring].
No. LVII. Sturgeon, *Acipenser güldenstaedtii*.
No. LVIII. Sterlet, *Acipenser ruthenus*.
No. LIX. Burbot, eel-pout, *Lota vulgaris*.

* Anales des Fleisches einiger Fische, Kgl. Ges. d. Wiss., Upsala, 1877.

No. LX. *Osmerus spirinchus.* [A kind of smelt].
No. LXI. *Meletta vulgaris.* [A kind of shad. *Clupea meletta*].
No. LXII. Salmon, *Salmo salar.*
No. LXIII. Halibut, *Hippoglossus maximus.*
No. LXIV. Great sturgeon, *Acipenser huso.*
No. LXV. River lamprey, *Petromyzon fluviatilis.*
No. LXVI. *Pelecus vulgaris.* [A kind of minnow.]
No. LXVII. *Alburnus chalcoides*, [Bleak].
No. LXVIII. *Leuciscus rutilus* var. *caspica*, [Roach].
No. LXIX. Cod, *Gadus morrhua.*
No. LXX. Caspian shad, *Alosa caspica, Clupea caspica.*
No. LXXI. Caviar of *Coregonus* species.
No. LXXII. Caviar of sturgeon.
No. LXXIII. *Coregonus leucichthys*, (Balyk.)
No. LXXIV. Sturgeon, (Balyk).
No. LXXV. Dorsal chords (Vezeega). [Back bones of sturgeon (?)].

Fishes analyzed by the writer.—Two specimens of European haddock, *Gadus æglefinus*, used in an investigation on the digestibility of fish (which was conducted in Munich, Germany, and is reported beyond) were analyzed with results as shown in Nos. LXXVI and LXXVII in the tables.

Fishes analyzed by Popoff.—The following list of names of Russian fishes and fish roe, analyzed by Popoff, is taken from the article by Professor Kostytscheff, referred to above, in which they are said to be quoted from a "dissertation for the degree of doctor of medicine," St. Petersburg, 1882. The names are from the translation above mentioned:

No. LXXVIII. Salt smelt (?)
No. LXXIX. Fresh smelt.
No. LXXX. Fresh vobla.
No. LXXXI. Smoked bream.
No. LXXII. Salt dried pike perch.
No. LXXXIII. Salt dried smelt.
No. LXXXIV. Roe of fresh vobla.
No. LXXXV. Roe of smoked bream.

The Russian names of Nos. LXXVIII and LXXXIII are different. That of LXXXIII is the same as No. LIII, which Prof. Kostytscheff translates into English as "Smelt, *Osmerus eperlanus.*"

Analyses by Sempolowski.—For reasons stated beyond, in connection with the quoted results, these analyses are not considered in detail in the present report, and hence the names of the species need not be given here.

2. RECAPITULATIONS OF ANALYSES OF EUROPEAN FISHES.

ANALYSES BY PAYEN.

Tables 10, 11, and 12 give the results of analyses by Payen. Table 10 gives the analyses of flesh in the form given by the analyst. Table 11 gives the proportion of refuse and flesh in the same specimens. In Table 12 the results are given in the forms used in this report.

Payen's analyses and statements were made before the methods now current had come into vogue, and a few changes of form of statement are necessary to make the results comparable with later ones. Thus (Table 10) instead of giving the percentages of nitrogenous substance,

Payen gives the percentages of nitrogen and adds that the nitrogeneous substance can be estimated by multiplying the nitrogen by the factor 6.5. We have used the factor 6.25. In making the recalculations for Table 12 we here follow Payen's figures, but have also noted the adaptations of the same made by König.*

Regarding the figures in Table 10 the following remarks may be made: In the analysis of sardines † the percentage of nitrogen is given by Payen in round numbers as 6, and in a way that seems to imply that this was not intended as an exact statement of the percentage. Accordingly we have not figured out the percentage of protein. In the analysis of Roach,† No. XV, the percentage of nitrogen is stated at 2.33. The protein calculated from this by multiplying by 6.25 would be 14.56. The percentage of ash is not stated, but even if it were as high as 2 per cent. it would make the protein (N × 6.25) only 14.56 per cent., while the albuminoids, etc., as estimated by difference would amount to 17.72. There is probably an error in the figures. Presuming that this error may be in the nitrogen I have omitted the percentage of protein from the table. In the specimen of salmon, No. XI, the percentage of nitrogen is given as 2.10, which would make 13.1 per cent. of protein, while the percentage of albuminoids by difference is 18.17. The probability of error here is such that the protein is omitted. The figures for fresh herring are calculated by Payen from the analysis of salt herring, and I therefore omit the protein in this case also. In the other analyses the footings of water + protein + fat + ash are pretty near 100.

TABLE 10.—*Analyses of the flesh of fishes by Payen.*

Names of fishes.	Reference No. of specimen.	Water.	Dry substance.	Fat.	Mineral matters.	Nitrogen.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Skate (Raie)	I	75.489	24.511	0.472	1.706	3.846
Conger eel (Anguille de mer, Congre)	II	79.909	20.091	5.021	1.106	2.172
Stockfish (Morue salée)	III	47.029	52.971	0.383	[2]21.320	5.023
Sardines (Sardines à l'huile)	IV	46.04	53.96	9.36	7.9	6.
Salt herring (Harengs salés)	V	48.998	51.002	12.718	[3]16.433	3.112
Herring (Harengs frais)[1]	VI	70.000	30.000	10.300	1.900	2.450
Whiting (Merlan)	VII	82.950	17.050	0.383	1.083	2.416
Mackerel (Maquerau)	VIII	68.275	31.725	6.758	1.846	3.747
Sole (Sole)	IX	86.144	13.856	0.248	1.229	1.911
Dab (Limande)	X	79.412	20.588	2.058	1.936	2.898
Salmon (Saumon)	XI	75.704	24.296	4.849	1.279	2.095
Pike (Brochet)	XII	77.530	22.470	0.602	1.293	3.258
Carp (Carpe)	XIII	76.968	23.032	1.092	1.335	3.498
Barbel (Barbillon)	XIV	89.349	10.651	0.212	0.900	1.571
Roach (Gardon)	XV	67.030	32.970	13.250	....	2.329
Gudgeon (Goujons)	XVI	76.889	23.111	2.676	[6]3.443	[4]2.779
Bleak (Ablettes)	XVII	72.889	27.111	[5]8.134	[6]3.253	2.689
Eel (Anguille)	XVIII	62.076	37.924	23.861	0.773	2.000

[1] The analysis of fresh herring is calculated from that of salt herring, and the figures are therefore only approximate.
[2] Including 19.544 per cent. salt.
[3] Including 14.623 per cent. salt.
[4] 2.77 in Payen, Subs. Alimentaires, 488.
[5] 8.03 in loc. cit.
[6] These specimens included the small bones with the flesh "since they are eaten entire;" hence the large percentages of mineral matters.

* Nahrungsmittel. 3te Aufl., 1, 201–207.

† In *Subst. Aliment.*, p. 488. The analysis is not given in the other report referred to. See remarks on analysis by König beyond.

TABLE 11.—*Proportions of refuse and flesh in fishes analyzed by Payen.*

Kind of fish.	Reference No. of specimen.	Refuse.	Flesh.	Kind of fish.	Reference No. of specimen.	Refuse.	Flesh.
		P. ct.	*P. ct.*			*P. ct.*	*P. ct.*
Skate	I	19.28	80.72	Dab	X	24.66	75.34
Conger eel	II	14.92	85.08	Salmon	XI	9.04	90.52
Stockfish	III	11.34	88.66	Pike	XII	31.88	68.12
Sardines	IV	19.54	80.46	Carp	XIII	37.15	62.85
Salt herring	V	12.00	88.00	Barbel	XIV	46.95	53.05
Whiting	VII	40.88	59.12	Gudgeon	XVI	....	100.00
Mackerel	VIII	22.13	77.87	Bleak	XVII	24.11	75.89
Sole	IX	13.86	86.14	Eel	XVIII	....	100.00

TABLE 12.—*Analyses of fishes by Payen, stated in the form used in the present report.*

Kind of fish	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids (by difference).	Fats.	Ash.	Nitrogen.	Protein (N × 6.25.)	Water+protein+fats+ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Skate	I	75.50	24.50	22.32	0.47	1.71	3.85	24.04	101.72
Conger eel	II	79.91	20.09	13.96	5.02	1.11	2.17	13.58	99.62
Stockfish	III	47.03	52.97	31.27	0.38	*21.32	5.02	31.39	100.12
Sardines (in oil)	IV	46.04	53.96	36.70	9.36	7.90	6.00	......	......
Salt herring	V	49.00	51.00	21.85	12.72	†16.43	3.11	19.45	97.60
Herring	VI	70.00	30.00	17.80	10.30	1.90	......	......	......
Whiting	VII	82.95	17.05	15.59	0.38	1.08	2.42	15.10	99.51
Mackerel	VIII	68.28	31.72	23.11	6.76	1.85	3.75	23.42	100.31
Sole	IX	86.14	13.86	12.38	0.25	1.23	1.91	11.94	99.56
Dab	X	79.41	20.59	16.59	2.06	1.94	2.90	18.11	101.52
Salmon	XI	75.70	24.30	18.17	4.85	1.28	......	......	......
Pike	XII	77.53	22.47	20.58	0.60	1.29	3.26	20.36	99.78
Carp	XIII	76.97	23.03	20.60	1.09	1.34	3.50	21.86	101.26
Barbel	XIV	89.35	10.65	9.54	0.21	0.90	1.57	9.82	100.28
Roach	XV	67.03	32.97	......	13.25	......	2.33	14.56	......
Gudgeon	XVI	76.89	23.11	16.99	2.68	‡3.44	2.78	17.37	100.38
Bleak	XVII	72.89	27.11	15.73	8.13	‡3.25	2.69	16.81	101.08
Eel	XVIII	62.08	37.92	13.29	23.86	0.77	2.00	12.50	99.21

* Including 19.54 per cent. salt. † Including 14.62 per cent. salt. ‡ Including small bones.

ANALYSES BY KÖNIG.

The analyses in Table 13, by Professor König and his assistants, Messrs. Brimmer, Farwick, and Krauch, are taken from König, *Nahrungsmittel*, as above stated. Some of the analyses are given in the *Zeitschrift für Biologie*, 1876, p. 507, others in the *Chem. u. tech. Untersuchungen an der Versuchstation, Münster*, 1878, *S.* 106.

In König's tables the protein (Stickstoff-Substanz) is estimated by multiplying the nitrogen by 6.25, the nitrogen having been determined by soda-lime. Where the sum of percentages, protein + fat (ether extract) + ash + water, is less than 100, the difference is taken as, "Non-nitrogenous extractives" (*N freie Extractstoffe*). We have altered the form of statement into that adopted for the tables of this report; that is to say, the amounts of "albuminoids by difference" are computed by subtracting the sum of the water, fats, and ash from water-free substance, and put in the place of the protein (N × 6.25) of König's table.

The protein is given, however, in another column, as in the previous table, and the sum of water, protein, fat, and ash are also stated. This permits the same comparisons as in the tables of analyses of American fishes. In the salt herring, the footing of water + protein + fats + ash is exactly 100 per cent. and in the smoked salmon it is exactly 99 per cent. Although these are round numbers I see no justification for assuming that they are other than accidental.

TABLE 13.—*Analyses of fishes by König and assistants.*

Kind of fish.	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids (by difference).	Fats.	Ash.	Nitrogen.	Protein (N × 6.25).	Water+protein+fats+ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Pike (Hecht)	XIX	77.37	22.63	21.46	0.79	0.38	3.18	19.86	98.40
Haddock (Schellfisch)	XX	80.97	19.03	17.05	0.34	*1.64	2.73	17.09	100.04
Salt herring (Häring)	XXI	47.12	52.88	18.97	16.67	17.24	3.04	18.97	100.00
Smoked and salted salmon (Lachs)	XXII	51.89	48.11	27.00	11.72	9.39	4.16	26.00	99.00
Anchovies (Sardellen)	XXIII	51.77	48.23	22.75	2.21	23.27	3.57	22.30	99.55
Cod or ling (Stockfisch, getrockneter Schellfisch)	XXIV	18.60	81.40	79.52	0.36	1.52	12.46	77.90	98.38
Smoked herring (Bücklinge)	XXV	69.49	30.51	20.76	8.51	*1.24	3.38	21.12	100.36
Spratt	XXVI	59.89	40.11	23.71	15.94	*0.46	3.64	22.73	99.02
Lamprey eel pickled (Neunaugen, marinirt)	XXVII	51.21	48.79	21.79	25.59	1.41	3.23	20.18	98.39

*After the extraction of calcium phosphate from bones and scales.

ANALYSES BY BUCKLAND.

The *Central-Blatt für Agrikulturchemie*, 1874, II, 75, contains reports of analyses of salmon and herring by F. Buckland, which are said to have been published in the *Circular des deutschen Fischereivereins*, 1875, *No.* 6, and republished in the *Archiv für Pharmacie*, 1874, *Bd.* 203, *Heft* 2, *S.* 178, from which latter the very brief account in the *Central-Blatt* is taken. The percentages are stated to have been calculated by the compiler of the article in the last-named journal from the English figures, which were given in absolute weights. Not having the original data at hand, I give in Table 14 the composition as stated by König (loc. cit.), who, as I infer from his statement, had the original figures. The fact that the footings are both exactly 100 suggest that one of the estimations may have been made by difference. The ash in the salmon is abnormally large.

TABLE 14.—*Analyses by Buckland.*

Kind of fish.	Reference No. of specimen.	Date of analysis.	Water.	Protein (nitrogen compounds).	Fat.	Ash.	Water + protein + fat + ash.	In water-free substance.	
								Nitrogen.	Fat.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Salmon, fresh	XXVIII	1874	77.06	13.11	4.30	5.53	100.00	9.23	18.74
Herring	XXIX	1874	80.71	10.11	7.11	2.07	100.00	8.39	36.86

ANALYSES BY ALMÉN.

As the original report* of Almén's investigations seems to have had a somewhat limited circulation, and only brief abstracts have appeared in the journals, it will not be amiss to cite some of the details. They may be best introduced by his tabular statement of results, which is translated as Table 15. The succeeding statements are freely translated or condensed from Almén's report.

TABLE 15.—*Analyses of fishes and of beef by Almén.*

Name of specimen.		A. Fresh fish and beef.								
		1	2	3	4	5	6	7	8	9
		Eel (Muræna anguilla).	Mackerel (Scomber scombrus).	Salmon (Salmo salar).	Little herring (Clupea harengus v. membras).	Beef (Bos taurus).	Plaice (Pleuronectes platessa).	Perch (Perca fluviatilis).	Common cod (Gadus callarias).	Pike (Esox lucius).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Soluble albumen	*a*	1.46	2.74	3.39	2.64	2.13	1.72	3.61	1.78	2.52
Insoluble protein compounds	*b*	8.14	11.84	11.02	11.76	14.29	12.31	9.01	9.33	7.64
Gelatin formers	*c*	2.04	1.01	1.50	2.53	1.46	3.17	3.74	2.69	2.82
Protein compounds	*d*	11.64	15.59	15.91	16.93	17.88	17.20	16.36	13.80	12.98
Extractive matters	*e*	1.78	1.87	2.15	2.30	1.95	2.15	1.76	1.58	1.85
Fat	*f*	32.88	16.41	10.12	5.87	2.28	1.80	0.44	0.20	0.15
Salts	*g*	0.92	1.70	1.49	1.65	1.13	1.46	1.38	1.44	1.13
Water	*h*	52.78	64.43	70.33	73.25	76.76	77.39	80.06	82.98	83.89
Water-free substance	*i*	47.22	35.57	29.67	26.75	23.24	22.61	19.94	17.02	16.11
Nitrogen	*k*	2.105	3.225	3.103	3.013	3.328	3.198	2.898	2.674	2.370
Protein compounds calculated from nitrogen	*l*	11.24	17.22	16.57	16.09	17.77	17.08	15.48	14.28	12.66
Insoluble salts	*m*	0.26	0.25	0.32	0.89	0.65	0.44	0.57	0.75	0.22
Soluble salts	*n*	0.66	1.45	1.17	0.76	0.48	1.02	0.81	0.69	0.91
Chlorine	*o*	0.013	0.173	0.043	0.079	0.059	0.140	0.061	0.097	0.186
Calculated on water-free substance. Protein compounds	*p*	24.65	43.83	53.62	63.29	76.94	76.07	82.04	81.08	80.57
Calculated on water-free substance. Extractive matters	*q*	3.77	5.26	7.25	8.60	8.39	9.51	8.83	9.28	11.48
Calculated on water-free substance. Fat	*r*	69.63	46.14	34.11	21.94	9.81	7.96	2.21	1.18	0.93
Calculated on water-free substance. Salts	*s*	1.95	4.77	5.02	6.17	4.86	6.46	6.92	8.46	7.02
Calculated on water-free substance. Nitrogen percentage	*t*	4.46	9.07	10.46	11.26	14.32	14.14	14.53	15.71	14.71

* Analyse des Fleisches einiger Fische, von Aug. Almén (Mitgetheilt der Königl. Gesellschaft der Wissenschaften zu Upsala am 7 April, 1877.) Upsala, 1877, 4to, 59 pp.

TABLE 15.—*Analyses of fishes and of beef by Almén*—Continued.

Name of specimen.		B. Salted fish.					C. Dried fish.		
		10	11	12	13	14	15	16	17
		Herring (Clupea harengus).	Mackerel (Scomber scombrus).	Salmon (Salmo salar).	Ling (Gadus molva vel morrhua).	Little herring (Clupea harengus v. membras).	Codfish (Gadus virens).	Codfish powder (Gadus).	Ling (Gadus molva).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Soluble albumen	*a*	1.71	1.28	2.73	0.60	1.00	5.36	3.38	1.86
Insoluble protein compounds	*b*	11.31	15.68	15.10	16.07	13.82	54.01	50.56	38.60
Gelatin formers	*c*	1.93	1.50	1.41	7.06	1.76	12.35	10.47	13.72
Protein compounds	*d*	14.95	18.46	19.24	23.73	16.58	71.72	64.41	54.18
Extractive matters	*e*	5.52	2.74	3.02	3.70	2.82	6.48	9.14	4.90
Fat	*f*	21.30	14.10	12.00	0.40	7.05	1.20	0.70	0.57
Salts	*g*	15.66	16.27	14.70	19.75	17.93	6.89	8.73	11.82
Water	*h*	42.57	48.43	51.04	52.42	55.62	13.71	17.02	28.53
Water-free substance	*i*	57.43	51.57	48.96	47.58	44.38	86.29	82.98	71.47
Nitrogen	*k*	2.925	3.331	3.581	4.575	3.100	12.79	12.17	9.46
Protein compounds calculated from nitrogen	*l*	15.62	17.79	19.12	24.43	16.55	68.30	65.00	50.51
Insoluble salts	*m*	1.43	1.13	0.72	1.42	0.83	3.83	7.00	2.29
Soluble salts	*n*	14.23	15.14	13.98	18.33	17.10	3.06	1.73	9.53
Chlorine	*o*	13.65	14.50	13.81	18.00	16.24	0.19	0.60	9.08
Calculated on water-free substance. Protein compounds	*p*	26.03	35.80	39.30	49.88	37.36	83.11	77.62	75.81
Calculated on water-free substance. Extractive matters	*q*	9.61	5.31	6.17	7.77	6.35	7.51	11.02	6.86
Calculated on water-free substance. Fat	*r*	37.09	27.34	24.51	0.84	15.89	1.39	0.84	0.79
Calculated on water-free substance. Salts	*s*	27.27	31.55	30.02	41.51	40.40	7.99	10.52	16.54
Calculated on water-free substance. Nitrogen percentage	*t*	5.093	6.459	7.314	9.62	6.985	14.82	14.67	13.23

METHODS OF ANALYSIS.

The execution of the analyses seems to have been in some respects less detailed than might have been the case. Thus many, if not most, of the more important determinations are not duplicated but made only once in each experiment. I would not, however, be understood to question the reliability of the results except in so far as single determinations are always uncertain. Agreement of duplicates by no means proves the correctness of an analysis but their failure to agree often calls attention to errors which might otherwise escape notice.

As regards the preparation of the material for the analysis, Almén, after speaking of the ease with which bones, tendons, and fat can be separated from the other tissues in meats, remarks as follows:

In investigating the colorless and almost white meat of fish the foreign ingredients can not be separated with the same facility and thoroughness as is done in the analysis of beef. In fish there are a great number of bones disseminated throughout the meat and which have the same color. These are very difficult to separate and portions remain in the flesh during the analysis, and through their richness in phosphate of lime and gelatin-formers increase the quantity of salts, especially the insoluble salts, and of gelatin. As it is, however, not intended in these investigations to make a comparison between the muscular tissues of fish and mammals, but a comparison between the different kinds of fish and beef as articles of food, the flesh of fish for investigation has been no more carefully prepared than is usual in the preparation of food for the table.

The scales were thoroughly removed from the fresh fish, their heads cut off, and the entrails taken out. The meat and skin were then separated as well as possible from the backbone, tail, and bony fins. The whole flesh thus obtained was cut fine, and carefully rubbed in a mortar until it formed a homogeneous mass, which was used for the analyses.

The water was determined in the flesh by heating 15 or 20 grammes, first at a lower temperature in a water bath and then at 110° C., to a constant weight. As the flesh grew horny and hard in drying it was from time to time stirred and pulverized with a glass rod or pestle, and thus ground fine so as to allow the escape of all of the water. Almén insists upon the necessity of thorough and complete drying, and believes that it was accomplished by this means.

The ash was determined by burning the dried substance in air. When necessary to avoid fusion of the alkaline salts and consequent imperfect ignition, the mass was first charred and then extracted with water. Where the ignition was practicable without this previous charring and extraction the ash was treated with water, and the soluble and insoluble salts weighed separately. Where the material was first charred the soluble salts were then extracted and weighed and the insoluble salts afterwards determined.

The chlorine was determined in the salts by a titration with a decinormal solution of silver nitrate. Almén remarks that—

In the fresh fish the chlorine occurs principally as potassium chloride; in the salt fish almost exclusively as sodium chloride. In the former the content of chlorine as shown by the analyses must be regarded as correct, while for the latter the amount of sodium chloride must be taken into account in order to determine the amount of salt used in salting the fish. A small portion of the chlorides may have been volatilized in the ignition, and the results of the determinations of ash and of chlorine thus rendered somewhat incorrect. Since, however, the method was the same in all of the cases, the figures that are given may be accepted as fair indications of the relative amounts actually present.

The amount of fat was determined by extracting the dried and pulverized flesh with ether to which a small quantity of 97 per cent. alcohol had been added. The ethereal solution was dried in a water-bath to constant weight. The extraction was always complete and the errors can not be important.

The nitrogen determinations were made by burning with soda lime. For this purpose 3 or 4 grammes of the finely divided and homogeneously mixed flesh were dried in a water bath. It was then very finely pulverized and carefully mixed with the soda lime.

The combustions were conducted first in glass tubes and afterwards in porcelain tubes, in which latter the operation went on more quietly. The ammonia was caught in a standard solution of sulphuric acid of normal strength and titrated against soda solution of one-third normal strength. In the first combustions, colored decomposition products appeared, imparting to the sulphuric acid a light-reddish color which made the titration somewhat uncertain. The litmus color was, nevertheless, predominant and the limits of error in the titration could not have exceeded 0.2 per cent. or at most 0.4 per cent. of the soda solution, which would correspond to from 1 to 2 milligrammes of nitrogen, which was of no importance for these investigations in view of their practical purpose. I succeeded, however, in avoiding these colored combustion products by filling the anterior part of the tube with coarse soda

lime, through which the products of the combustion were obliged to pass. When, however, only the fine soda lime was used the colored products passed over without being decomposed.

Almén insists upon the finest practicable pulverization and careful mixing of the substance with soda lime, which latter had been carefully tested by combustion with sugar to prove its purity:

As an indication that the nitrogen determinations were reliable and correct, within the limits required for their purpose, I may state that two determinations with fish meal gave, respectively, 12.17 per cent. and 12.21 per cent. of nitrogen, and two others with fresh flesh of cod gave, respectively, 2.63 per cent. and 2.72 per cent. of nitrogen. The disagreement of duplicates thus did not exceed 0.1 per cent. of nitrogen or 0.5 per cent. of protein.

In speaking of our own attempts at determining the nitrogenous ingredients directly, Section A, Division 2, I referred to the fact that these determinations were made as much for the purpose of testing the methods, and for comparing the results with those obtained by other investigators, as for the sake of the results themselves. I had especially in mind the work of Almén, who has made a considerable number of estimations of albumen, other substances soluble in water, gelatin-formers, and the extractive matters. The descriptions of his methods as well as his results seem worthy of somewhat detailed statement here, since this work with that of Kostytschef, which I presume to have been conducted by similar methods, constitutes the most extensive contribution we have to the knowledge of this particular subject.

Almén lays especial stress upon the comparison between the composition of beef and that of the several kinds of fishes which he analyzed, the analyses of the beef and fish being made by the same methods. The albumen soluble in water, the gelatin-forming substances (gelatinoids as they are sometimes called), and the extractive matters were estimated as follows:

The determination of these several constituents were made in each case in a single portion of the flesh, generally about 33.3 grammes, which had been finely divided and well mixed as previously stated. The flesh was placed in about 250 grammes of distilled water, stirred and allowed to stand from 8 to 12 hours, with frequent stirring, and then filtered through paper by means of a Bunsen filter pump. The undissolved portion was then extracted in like manner a second time, with the same quantity of distilled water, and washed once on the filter. The filtrates and the washings, which together made about 600 cubic centimeters, were then boiled down in a porcelain dish to about 70 to 100 cubic centimeters. In this process the albumen separated out in coarse flocculent masses which were easily filtered. They were placed upon the filter, washed with hot water, completely dried at 110° C., and weighed between two watch-glasses. In working with some kinds of fish, it happens that in the second extraction with cold water the insoluble portion assumes a gelatinous form similar to syntonin, and is difficult to filter. By use of the Bunsen pump and a goodly amount of patience, the filtration always succeeded.

The longer the extraction was protracted with new portions of water, the more gelatinous the residue became, without, however, any considerable quantity of soluble albuminous matter passing into the solution. This was particularly the case with perch. Whether this peculiarity of the flesh of some of the fishes depended

upon lack of acid in the muscle, upon the way they were killed, or upon the fact that the fishes in question had been frozen and that the flesh had thereby suffered some alteration, or whether it was due to other causes, I can not say. In the boiling of the extract, complete coagulation was not obtained until a small quantity, 5 to 10 drops, of acetic acid had been added. The flesh of some fishes gives a second filtrate of so slight acidity that boiling alone, without addition of acetic acid, does not cause a complete separation of the albuminoids. On this account the filtration proceeds very slowly, and there is formed on the surface of the filtrate during the subsequent evaporation a casein-like film. This occurs when a little acetic acid had been added during the boiling for precipitating the albumen. When the amount of the precipitated albumen is considerable, from 0.5 gramme to 1.0 gramme, a complete drying upon the filter is tedious and difficult. But if the partly dried and reasonably solid mass which sticks to the filter is separated in thin layers by means of a sharp pen-knife and placed upon a watch-glass, the drying is rapid and complete.

The filtrate from the precipitated albumen was evaporated in a platinum capsule over a water bath and then completely dried at 110° C. and weighed. Thereafter it was ignited at a low heat, generally in the same platinum capsule, which, during the incineration, was covered with a larger capsule, the latter thus serving as a loosely fitting cover. The light-colored ash thus produced was weighed and its weight subtracted from the total weight of the dried substance, the loss being taken as the amount of the extractive matters. If, however, the direct ignition was not satisfactory, the amounts of the soluble and insoluble salts were determined separately and their sum subtracted from the total weight of the dried substance.

The portion of the flesh which did not dissolve in water was carefully removed from the filter and boiled for about 12 hours in a porcelain dish with a larger amount, 500 to 600 cubic centimeters of water. The porcelain dish was covered with a large funnel and as the water boiled away it was replaced by distilled water. During the boiling, thin yellow films formed on the sides of the evaporating dish. These had the appearance of gelatin but were not soluble in boiling water. Boiling in a glass flask was not successful on account of the heavy bumping, by which the contents were at times projected out of the flask. This occurred once or twice in the boiling in the porcelain evaporating dish. The solution of gelatin was filtered boiling hot, the insoluble portion boiled again with a larger amount of water, filtered, and washed with boiling hot water. The gelatin solution, which was usually light yellow in color, was concentrated by evaporation in a porcelain dish to a small volume, then transferred to a platinum capsule and dried, first over a water bath and then in the drying oven. The residue had the appearance of a fine jelly, but did not become hard on cooling.

This gelatin is not entirely pure. It contains especially, besides other matters, some salts insoluble in cold water. The gelatin from the plaice, for instance, contained 3 per cent. of ash corresponding to 0.1 per cent. of the total flesh. The parallel determinations from the same flesh gave results which agreed well with one another. The perch, for instance, yielded in two determinations 3.71 per cent. and 3.77 per cent. of gelatin. The amount of gelatin obtained in the second 12 hours' boiling, though appreciable, is very small in comparison with that yielded by the first 12 hours' boiling. In my opinion, the determinations of the gelatinoids are the least reliable of all. They are, nevertheless, sufficiently accurate for comparison, since they were all conducted by the same method.

In regard to the remaining nitrogenous material, Almén remarks:

The insoluble protein, for reasons easily seen, can not be directly determined. On this account, it is usual to determine by differences. The total water-free substance minus the sum of the salts, fat, extractives, gelatinoids, and soluble albumen, gives the insoluble protein. All the errors which may be made, in the determinations of the other substances named, thus appear in the estimation of the insoluble protein.

In other words, the insoluble protein was not directly determined, but was estimated by difference.

Since this is one of the most important constituents of the flesh, Almén had recourse to direct determination of nitrogen and the computation of the amount of total protein matters from the percentage thus obtained.

PERCENTAGE OF NITROGEN IN PROTEIN COMPOUNDS.

The subject of the percentages of nitrogen in the flesh of fish is treated at some length by Almén. I quote his language:

The percentage of nitrogen, without doubt, demands special consideration, because it is a measure of the amount of protein compounds. When we consider the varying percentage of fat, we might expect wide variations. The amounts of nitrogen in the flesh of fish, however, range between 2.1 per cent. and 3.2 per cent., while beef contains 3.33 per cent. The plaice comes next to beef, with 3.20 per cent. Consequently it contains more protein matters than any other fish studied. By comparing the series (*d*) and (*e*) (of table 15 above) it will be seen that the percentages of nitrogen are a correct measure of the relative amounts of protein.

The amount of protein computed from the determined percentages of nitrogen depends, of course, upon the number by which the latter percentages are multiplied or, in other words, upon the nitrogen percentage-coefficient [nitrogen factor] of the flesh. The percentage of nitrogen in the true protein compounds [albuminoids and gelatinoids] varies from 15.4 to 16.5 per cent., and averages 16 per cent., from which it follows that, to obtain the percentage of actual protein compounds, we have to multiply the nitrogen in the latter by 6.25, or, in other words, 6.25 is the nitrogen percentage-coefficient (nitrogen factor) for pure protein compounds in general. This coefficient is often used in calculating the amount of protein in vegetable as well as in animal food materials.

Referring now to the amount of protein compounds in the flesh of fish, it may be noted that Payen gives the nitrogen percentages of different fish and adds (in a footnote) that the amount of protein may be obtained by multiplying the percentage of nitrogen by 6.5. Letheby, in like manner, in a table of the composition of various food materials, gives their contents of nitrogen and protein compounds, the latter being 6.5 times as large as the former. Pavy employs the same coefficient, following the figures in Letheby's table.

This method of calculating the amount of protein compounds in meat and other food materials in the same way as for pure protein compounds, namely, by multiplying the nitrogen percentages by 6.25, leads to gross errors, because flesh is in no way pure protein, but contains a number of other ingredients, namely the extractive matters, some of which are non-nitrogenous (inosite), while others which are rich in nitrogen (kreatin, hypoxanthin, etc.) might, with as good reason, be counted as worthless as ranked with protein. The common "Liebig's meat extract" is said to contain 9 to 10 per cent. of nitrogen and 33 to 40 per cent. of salts and water. Taking these out, the remainder corresponds to the water-free extractive matters, which are said to contain about 15 per cent. of nitrogen or nearly the same proportion as the pure protein compounds. Now, since flesh contains about 2 per cent. of extractive matters with about the same content of nitrogen as the protein compounds, it is clear that the amount of protein compounds obtained by multiplying the nitrogen by 6.25 must be too large, and in no way corresponds to the actual quantity of pure protein compounds present but, rather, very closely to the sum of these and the extractive matters.

Almén's point, that multiplying the total nitrogen, including that which belongs to the extractives as well as that in the protein compounds, albuminoids, and gelatinoids, by 6.25 would give a product

larger than the actual amount of protein compounds, is too evident to require argument. He adduces, however, figures from Payen's and Pettenkofer and Voit's analyses, as well as his own, from which he computes that in the water-free substance of lean beef the actual amounts of protein compounds could hardly be more than 77 per cent., while the ordinary computation would make them as high as 88 to 92 per cent.

In view of the labor involved in direct determinations of the actual amount of protein compounds, exclusive of extractive matters, Almén has attempted to find what proportion of the nitrogen actually belongs to these compounds, or, to speak more properly, by what factor the total nitrogen should be multiplied in order to yield figures corresponding with the actual amounts of protein compounds. For this purpose he takes the sums of the soluble albumen, the gelatinoids, and the other protein compounds in eight different specimens of flesh of fish and one of beef (which numbers are found in the line designated by (*d*) in Part A of Table 15), and adding them together finds their sum to be 138.29 per cent. The sum of the corresponding percentages of nitrogen, line (*k*) in the same table, is 25.914 per cent. Dividing the former of these two sums by the latter he obtains the quotient 5.34, which he designates as the coefficient by which the percentage of nitrogen in the flesh should be multiplied in order to give the actual amount of protein compounds in the flesh. He then assumes that the multiplication of the percentage of nitrogen in any one of the specimens of fish analyzed, fresh, salt, or dried, will give the actual amount of protein. These calculated amounts he gives in line (*e*) of his table. The amounts of protein as directly determined then compare with the amounts thus calculated, as shown in Table 16.

TABLE 16.—*Comparison between percentages of protein compounds as directly determined and as computed by multiplying the total nitrogen by* 5.34.

Fresh fish and lean beef.			Dried and salted fish.		
In flesh of—	Protein compounds.		In flesh of—	Protein compounds.	
	Directly determined.	Computed from nitrogen.		Directly determined.	Computed from nitrogen.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Eel	11.64	11.24	Salted herring	14.95	15.62
Mackerel	15.59	17.22	Salted mackerel	18.46	17.79
Salmon	15.91	16.57	Salted salmon	19.24	19.12
Little herring	16.93	16.09	Salted ling	23.73	24.43
Plaice	17.20	17.08	Salted little herring	16.58	16.55
Perch	16.36	15.48	Dried pollock	71.72	68.30
Cod	13.80	14.28	Dried cod (powdered)	64.41	65.00
Pike	12.98	12.66	Dried ling	54.18	50.51
Lean beef	17.88	17.77			

It will be borne in mind that the direct determination of protein was more properly a determination by difference, since it was made by subtracting the sum of the extractive matters, fat, and ash from the total water-free substance. Any errors, therefore, which might have occurred in the determinations of either ash, fat, or albumen would enter into this

estimation of the protein. The fact that the majority of the determinations of these substances were made not in duplicate but singly would, unless unusual care was exercised in the work, leave grounds for fear that errors might have entered into them. That Almén was himself persuaded that his determinations might not have been free from mistakes, he takes pains to state in his references to the differences which occur between the amounts of protein as estimated by the two methods. Thus, the quite wide differences between the two estimations in the fresh mackerel (1.6 per cent.) and in the perch (0.9 per cent.) he attributes to probable errors in the nitrogen determination. While I would wish to refrain from criticism of the labor of a fellow-investigator, it is not easy to avoid the feeling that greater care in the analytical work would have yielded less uncertain results. At the same time, my own analyses,* already given, show variations between the amounts of protein as directly determined (albuminoids by difference of the tables) and the amounts obtained by multiplying the nitrogen by 6.25 as large as, or nearly as large as, those here stated, though of course in my own analyses the protein refers to the whole nitrogenous material, while in this case Almén includes only the true protein compounds, the albuminoids and the gelatinoids, the extractive matters being excluded.

SOLUBLE AND INSOLUBLE SALTS, CHLORINE, ETC.

Some of Almén's other conclusions are of decided interest. The insoluble salts he regards as including, in some cases, the phosphates of the small bones which are not separated from the flesh. The soluble salts vary between 0.5 per cent. and 1.5 per cent. in the flesh. The smallest portion was in the lean beef; the percentage in the different kinds of flesh of fishes being considerably larger.

The amount of chlorine is very insignificant. No difference is observable, either between the chlorine in the fresh-water and sea-water fishes or between the flesh of fishes and lean beef; but, as Almén observes, it is to be remembered that the chlorine was determined in the ash, from which a portion may have escaped in the ignition.

STATEMENTS REGARDING INDIVIDUAL SPECIMENS.

As stated above, in the descriptions of the methods of analysis, Almén analyzed the flesh and skin of the fish together, regarding these as constituting the edible portion and the remainder as refuse. Reference to the details of his memoir, however, shows that in some cases the flesh alone was used, the skin being rejected. The following statements in Almén's description of the individual specimens are also worthy of especial record:

No. XXX. The first specimen in the table was, "An ordinary fresh-water eel weighing 328 grammes. The skin was removed and weighed 35 grammes or 11 per cent. of the whole. The flesh freed from bones and other refuse weighed 209 grammes, or 64 per cent. of the whole eel. The head and other parts not used for food amounted to 36 per cent." In this very fat fish, therefore, the refuse, as Almén remarks, made up a

* See Section A, Divisions 4 (Tables 2 and 3) and 5, above.

much smaller proportion of the whole weight than is usually the case with fishes. The specimen thus analyzed consisted of flesh without skin.

No. XXXI. "The specimen of fresh mackerel was of the kind which occur in late autumn in the bays on the Swedish coast and are very fat. This specimen was quite small."

No. XXXII. "This specimen was taken from a salmon estimated to weigh about 6½ kilos. It consisted of a slice across the middle of the fish intended to include the leaner flesh of the back and the fatter flesh of the belly." The attempt was evidently made to secure a slice that would fairly represent the composition of the whole of the flesh. The flesh freed from skin was used for the analysis.

No. XXXIII. The specimen of "little herring" (whitebait"?) included 7 fish, weighing together 198 grammes. The head, bones, scales, and entrails weighed 66 grammes, or 33 per cent., the milt and spawn 22 grammes, or 11 per cent., the flesh and skin which were taken for analysis, 110 grammes, or 55 per cent. of the whole weight.

No. XXXV. The specimen of perch consisted of one entire fish weighing 403 grammes, of which the roe constituted 10 per cent., the head 20 per cent., and these, with the entrails, bones, and other refuse, 59 per cent. of the whole weight, the edible portion, flesh, and skin making 41 per cent.

No. XXXVII. The specimen of pike consisted of one very small fish, weighing only 260 grammes, of which the edible portion, flesh, and skin, freed from scales, made 53 per cent.

No. XXXVIII. The salt herring was "one of the ordinary Norwegian *Tonnen härringe*," which I understand to be herring salted in brine. The specimen was smaller and leaner than usual. The edible portion, flesh, and skin of a large herring was found to constitute 69 per cent. and that of a small one 63 per cent. of the total weight of the fish, from which Almén takes 66 per cent. as the average amount of edible portion in these fish.

No. XXXIX. The salted mackerel are the so-called fat mackerel taken in late autumn on the Swedish coast. These are cleaned, heavily salted and packed in small kegs. On account of their fatness they are highly prized, bringing higher prices than the Norwegian herring. The specimen analyzed consisted of flesh and skin.

No. XL. The next specimen is described as "one of the ordinary salted salmon, as it is commonly found in large flat pieces." The specimen consisted of the flesh and skin, freed from scales.

No. XLI. The ling is described as "the ordinary Kabeljau as it occurs in the markets, dried and salted in tubs without brine." The flesh, with the skin freed from scales, was analyzed.

No. XLII. This consisted of 9 salt herring ("Little herring," Germ. Strömling) a kind very common in the Swedish market, salted in brine in tubs. The specimen was of inferior quality. The 9 fish, after the brine had been wiped off with a cloth, weighed only 217 grammes, of which the edible portion (both flesh and skin?) made 61 per cent.

No. XLIII. This is designated by Almén as "Stockfish, *Gadus virens*, codfish." The *Gadus virens*, however, is not what we ordinarily call in English codfish, but rather the pollock or coal fish. Almén describes the specimen as ordinary stockfish, dried, unsalted, and with a brownish yellow flesh, and so hard and tough and horny that it was impossible to cut it with a knife. "I was obliged to pound the knife with a hammer, and thus succeeded in dividing the fish into small pieces which were pounded up in a mortar to a coarse homogeneous powder."

No. XLIV. This fish-meal (fischmehl) is described as a "light-yellow, loose powder which has lately come into our markets, and consists of short elastic fibers (muscle fibers). It has a slight odor similar to that of dried fish, and is nearly tasteless." According to this description, the specimen must be very similar in appearance, odor, and taste to the dessicated cod, No. 80, described in the analyses of American preserved fishes.

No. XLV. Of the ling, Almén speaks as follows: "In the preparation of this fish, it is customary to cut off the head and remove the entrails and backbone. The two

sides, which remain together, are spread out, and thus dried. In this form it comes into the market. The ling is not salted before drying. I believe, however, that after it has been cleaned, it is allowed to lie for a short time in sea water to remove the blood and coloring matter and give the fish a white and attractive appearance. The specimen analyzed had the ordinary appearance, and was so dry, tough, and hard that it was only with the help of a hammer and knife that I succeeded in cutting it up into small pieces. The flesh and skin were then pulverized and used for the analysis."

Tables 17 and 18 give the results of Almén's analyses in the form used in this report. The percentage of "albuminoids, etc., by difference" and for protein (N × 6.25) are computed from Almén's figures. As shown in the last column of Table 18, the sum of the water, protein (N×6.25), fats, and ash in the flesh came very near to 100 in most of the cases. In our analyses of American fishes the sums of these ingredients in the cod and other species of *Gadus* exceeded 100. Almén's results are very similar. One of the specimens of mackerel comes up quite high, 102.7 per cent. The correctness of this analysis is, however, called in question by Almén. The data of Table 18 are not exactly comparable with those of the corresponding table of analyses of American fishes, since, in most cases, the specimens include, with the flesh, the skin, which is richer in gelatinoids, while our analyses were made with the flesh alone. In our analyses, the insoluble albuminoids (insoluble protein) were determined directly, while the estimates in Almén's are by difference. Rather more pains were taken, in our analyses, to determine the ash and fat in the albuminoids, etc. The methods of analysis were otherwise essentially the same.

TABLE 17.—*Analyses of fish, etc., by Almén (figures recalculated to the forms used in this report).*

Names of fishes.	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids (by difference).*	Fats.	Ash.†	Nitrogen.	Protein, N×6.25.	Water protein +fats+ash.
FRESH FISH.		*P. ct.*	*P. ct.*	*P. ct*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Eel‡	XXX	52.78	47.22	13.42	32.88	0.92	2.11	13.16	99.74
Mackerel	XXXI	64.43	35.57	17.46	16.41	1.70	3.23	20.16	102.70
Salmon ‡	XXXII	70.33	29.67	18.06	10.12	1.49	3.10	19.39	101.33
Little herring	XXXIII	73.25	26.75	19.23	5.87	1.65	3.01	18.83	99.60
Plaice	XXXIV	77.39	22.61	19.35	1.80	1.46	3.20	19.99	100.64
Perch	XXXV	80.06	19.94	18.12	0.44	1.38	2.90	18.11	99.99
Common cod	XXXVI	82.98	17.02	15.38	0.20	1.44	2.67	16.71	101.33
Pike	XXXVII	83.89	16.11	14.83	0.15	1.13	2.37	14.81	99.98
SALTED FISH.									
Herring	XXXVIII	42.57	57.43	20.47	21.30	15.66	2.93	18.28	97.81
Mackerel	XXXIX	48.43	51.57	21.20	14.10	16.27	3.33	20.82	99.62
Salmon (smoked?)	XL	51.04	48.96	22.26	12.00	14.70	3.58	22.38	100.12
Ling	XLI	52.42	47.58	27.43	0.40	19.75	4.58	28.60	101.17
Little herring	XLII	55.62	44.38	19.40	7.05	17.93	3.10	19.38	99.98
DRIED FISH.									
Stockfish (pollock?)	XLIII	13.71	86.29	78.20	1.20	6.89	12.79	79.94	101.74
Codfish (?) powder (Fischmehl)	XLIV	17.02	82.98	73.55	0.70	8.73	12.17	76.06	102.51
Ling	XLV	28.53	71.47	59.08	0.57	11.82	9.46	59.12	100.04

† Including salt of salted fish.
* Water-free substance—fats and ash.
‡ These specimens consisted of the flesh alone; the others included the skin with the flesh.

TABLE 18.—*Analyses of fish by Almén. Proximate ingredients directly determined.*

Names of fish.	Reference No. of specimen.	Water.	Extractives.	Gelatinoids.	Albuminoids. Soluble.	Albuminoids. Insoluble (by difference).	Fat.	Ash.
FRESH FISH.		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Eel	XXX	52.78	1.78	2.04	1.46	8.14	32.88	0.92
Mackerel	XXXI	64.43	1.87	1.01	2.74	11.84	16.41	1.70
Salmon	XXXII	70.33	2.15	1.50	3.39	11.02	10.12	1.49
Little herring	XXXIII	73.25	2.30	2.53	2.64	11.76	5.87	1.65
Plaice	XXXIV	77.39	2.15	3.17	1.72	12.31	1.80	1.46
Perch	XXXV	80.06	1.76	3.74	3.61	9.01	0.44	1.38
Common cod	XXXVI	82.98	1.58	2.69	1.78	9.33	0.20	1.44
Pike	XXXVII	83.89	1.85	2.82	2.52	7.64	0.15	1.13
SALTED FISH.								
Herring	XXXVIII	42.57	5.52	1.93	1.71	11.31	21.30	15.66
Mackerel	XXXIX	48.43	2.74	1.50	1.28	15.68	14.10	16 27
Smoked salmon	XL	51.04	3.02	1.41	2.73	15.10	12.00	14.70
Ling	XLI	52.42	3.70	7.06	0.60	16.07	0.40	19.75
Little herring	XLII	55.62	2.82	1.76	1.00	13.82	7.05	17.93
DRIED FISH.								
Stockfish	XLIII	13.71	6.48	12.35	5.36	54.01	1.20	6.89
Codfish powder	XLIV	17.02	9.14	10.47	3.38	50.56	0.70	8.73
Ling	XLV	28.53	4.90	13.72	1.86	38 60	0.57	11.82

TABLE 19.—*Estimated proportions of refuse, water, and nutrients in specimens of European fishes analyzed by Almén.*

Kind of fish and portion analyzed.	Reference No.	Refuse.	Edible portion.	In edible portion. Water.	In edible portion. Water-free substance.	Water-free substance. Albuminoids, etc.†	Water-free substance. Fats.	Water-free substance. Ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Eel, whole	XXX	36	*64	33.8	30.2	8.6	21.0	0.6
Little herring, whole	XXXIII	45	55	40.3	14.7	10.6	3.2	0.9
Perch, whole	XXXV	59	41	32.8	8.2	7.4	0.2	0.6
Pike, whole	XXXVII	47	53	44.5	8.5	7.8	0.1	0.6
Salted herring, whole?	XXXVIII	34	66	28.1	37.9	13.5	14.1	‡10.3
Salted little herring, whole?	XLII	39	61	33.9	27.1	11.9	4.3	§10.9

* The "edible portion" in this case consisted of flesh only; in the other specimens in this table it included flesh and skin.
† Estimated "by difference." See foot note, Table XVI.
‡ Including 5.2 per cent. salt; in XXXVIII, 13.7.
§ Including 4.4 per cent. salt.

ANALYSES BY KOSTYTSCHEFF.

In the Russian exhibit at the International Fisheries Exhibition in London, in 1883, were shown some copies of reports of analyses of Russian fishes by Professor Kostytscheff, of the Agricultural Station at St. Petersburg. These were simply charts giving the name and figures without explanations. From copies, which I owe to the courtesy of Professor Goode, United States Commissioner to the Exhibition, Table 26 is transcribed. The only alterations are the insertion of reference

numbers, the addition of names in brackets (see list of names above), and corrections of a few typographical errors. These changes were made after comparison with the detailed account by Professor Kostytscheff, which was received after this report had been prepared for the printer. Kostytscheff's account,* a translation of part of which is given beyond, includes a discussion of the analyses of Payen, Konig, and Almén as well as his own. The statements imply that his analyses were made by methods similar to those used by Almén, both following Hoppe-Seyler.

In Table 21 the results are calculated into the forms used for this report. The figures for water-free substance represent the difference between the percentages of water and 100 per cent. Those for "albuminoids by difference" are found by subtracting the sum of the percentages of fats and ash from that of water-free substances. I have added the percentages of water, extractive matters, gelatinous principles, albuminous principles, fat, and ash, in Table 21, and find the footings to be 100 per cent. in all cases but three. In the pike, No. L, it amounts to 99.90 per cent; in the salmon, No. LIV, to 98.90 per cent; and in the *Coregonus leucichthys*, No. LXXIII, to 99.99 per cent. (In table [20] in Professor Kostytscheff's article the ash in LXXIII is 13.17 per cent., which would make a total of 99.89 per cent.) I infer that these variations from 100 per cent. are due simply to typographical errors. Those in Nos. L and LXXIII are so small that they may be left out of account. That of LIV, though larger, amounts to only 1.1 per cent., hardly enough to make it necessary to discard the analysis.

Almén estimated the amount of insoluble protein by difference; if the percentage of "albuminous matters" in these analyses are estimated in the same way, as would appear from Kostytscheff's statements, we should infer that direct determinations had been made of the water, extractive matters, gelatinous principles, fat, and ash. The calculations in Table 20 are made on the supposition that the percentages of water, fats, and ash were directly determined. If this assumption be correct, the only cases in which this table is in error would be the three above mentioned, L, LIV, and LXXIII, the only considerable error being that of 1.1 per cent. in the salmon, LIV. I regret that I have no data for either verifying the assumptions or correcting the minor errors named.

The portions of fish analyzed by Kostytscheff, when not otherwise stated, included only the flesh. The "balyk" (the Russian term for the flesh of fish dried in the sun), No. LXXIII, is said by Kostytscheff to be "too dry; the fresh balyk ought to contain at least 48 to 50 per cent. of water, with corresponding amounts of other constituent parts."

One of the specimens, No. LIX, is that of liver of burbot, in which

* The Chemical Composition of Fish Products, with some remarks on their nutritive value. By Prof. P. Kostytscheff, from the Russian "Journal of Rural Economy and Forestry," vol. CXLIV, part II. The translation was furnished through the kindness of Prof. S. F. Baird, U. S. Commissioner of Fish and Fisheries.

non-nitrogenous "extractive matters" would be expected to occur in some quantity. Thus von Bibra (see analyses of liver of fish beyond) reports from 0.4 to 13.5 per cent. of these substances in livers of pike, trout, and carp. As Professor Kostytscheff's analyses are reported, no account is made of these constituents. If they were actually present, the percentage of "albuminous matters" (protein) must have been less than stated by an amount equivalent to that of the non-nitrogenous matters.

TABLE 20.—*Analyses of fishes of Russia by P. Kostytscheff, professor at the Agricultural Station in St. Petersburg.*

Names of fishes.	Reference No. of specimen.	Water.	Extractive matter.	Gelatinous principles.	Albuminous matter.	Fat.	Ash.	Common salt (Na Cl).	Phosphoric acid (P_2O_5).	Iron oxide (Fe_2O_3).
FRESH FISH.		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sigg	XLVI	79.13	2.93	3.70	11.69	1.53	1.22	......	0.4711	0.0031
Pike perch (Lucioperca sandra)	XLVII	79.87	3.28	3.55	12.10	0.20	1.00	......	0.2602	0.0023
Codfish	XLVIII	81.02	3.45	4.24	10.11	0.07	1.11	......	0.3731	0.0018
Carp	XLIX	79.89	3.92	2.84	10.79	1.42	1.14	......	......	......
Pike	L	80.70	3.14	3.32	11.23	0.33	1.18	......	0.3989	0.0034
Crucian carp	LI	80.82	4.56	3.63	9.41	0.48	1.07	......	......	......
Gadus navaga	LII	81.35	4.99	2.46	9.03	0.59	1.58	......	0.4833	0.0041
Smelt (Osmerus eperlanus)	LIII	78.38	4.14	2.83	10.00	3.08	1.57	......	......	......
Salmon	LIV	62.02	2.70	5.08	12.98	14.82	1.30	......	0.3822	0.0035
Salmon trout	LV	75.35	3.11	1.71	16.01	2.49	1.33	......	0.3998	0.0040
Herring (whitebait?)	LVI	76.11	2.54	1.29	13.46	4.89	1.71	......	......	......
Sturgeon (Acipenser güldenstædtii)	LVII	76.02	3.05	1.58	13.04	5.15	1.16	......	0.2993	0.0027
Sterlet	LVIII	76.81	1.69	1.74	13.21	5.59	0.96	......	0.3104	0.0023
Liver of burbot (eel-pout)	LIX	45.58	2.55	1.01	5.36	44.89	0.61	......	......	......
PRESERVED FISH.										
Salted and dried entire Osmerus spirinchus	LX	47.12	3.56	2.27	20.55	8.03	18.47	13.14	1.3701	0.1341
Marinated and entire Meletta vulgaris	LXI	60.72	3.73	3.06	3.79	17.14	11.56	9.90	......	......
Salted flesh of salmon (Semga)	LXII	53.48	3.96	5.08	13.64	12.19	11.65	11.21	......	......
Salted flesh of the halibut (Hippoglossus maximus)	LXIII	54.65	5.57	1.09	16.83	6.82	15.04	13.77	0.4007	0.0041
Salted flesh of the great sturgeon (Acipenser huso)	LXIV	61.85	1.83	2.05	14.82	8.93	10.52	10.03	......	......
Marinated entire river lamprey	LXV	44.62	2.70	4.05	27.57	16.57	4.49	3.33	......	......
Salted and smoked flesh of Pelecus vulgaris	LXVI	54.89	5.42	6.14	18.48	5.87	9.20	7.99	......	......
Salted and smoked flesh of Alburnus chalcoides	LXVII	43.53	6.37	3.47	18.99	16.21	11.43	9.86	......	......
Salted and dried flesh of roach (Leuciscus rutilus, var. caspica)	LXVIII	27.96	9.44	8.23	30.18	9.88	14.31	8.92	......	......
Dried flesh of codfish	LXIX	25.23	5.21	13.23	50.44	0.69	5.20	1.20	......	......
Salted flesh of Caspian shad	LXX	59.56	3.78	4.87	13.41	8.86	9.52	8.98	0.2733	0.0020
Salted caviar of Coregonus species	LXXI	66.05	2.16	1.19	14.37	8.97	7.26	6.16	......	......
Fresh caviar of sturgeon	LXXII	56.97	1.62	0.78	25.47	12.85	2.31	0.35	1.0340	0.0047
Salted and dried backs of Coregonus leucichthys (Balyk)	LXXIII	57.55	3.99	4.59	14.91	13.17	5.78	4.13	......	......
Salted and dried backs of sturgeon (Balyk)	LXXIV	36.67	8.34	2.63	31.08	14.35	6.93	3.53	......	......
Dried cartilaginous dorsal cords (Vezega)	LXV	50.99	5.21	40.04	0.18	0.06	3.52	......	......	......

TABLE 21.—*Analyses of Russian fishes by Kostytscheff, recalculated to forms used in this report.*

Names of fishes.	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids, etc. (by difference.)	Fats.	Ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sigg	XLVI	79.13	20.87	18.12	1.53	1.22
Pike perch (L. sandra)	XLVII	79.87	20.13	18.93	0.20	1.00
Codfish	XLVIII	81.02	18.98	17.80	0.07	1.11
Carp	XLIX	79.89	20.11	17.55	1.42	1.14
Pike	L	80.70	19.30	17.79	0.33	1.18
Crucian carp	LI	80.82	19.18	17.63	0.48	1.07
Gadus navaga	LII	81.35	18.65	16.48	0.59	1.58
Smelt (O. eperlanus)	LIII	78.38	21.62	16.97	3.08	1.57
Salmon	LIV	62.02	37.98	21.86	14.82	1.30
Salmon trout	LV	75.35	24.65	20.83	2.49	1.33
Herring (white bait?)	LVI	76.11	23.89	17.29	4.89	1.71
Sturgeon (A. güldenstædtii)	LVII	76.02	23.98	17.67	5.15	1.16
Sterlet	LVIII	76.81	23.19	16.64	5.59	0.96
Liver of burbot	LIX	45.58	54.42	8.92	44.89	0.61
PRESERVED FISH.						
Salted and dried Osmerus spirinchus	LX	47.12	52.88	26.38	8.03	18.47
Marinated Meletta vulgaris	LXI	60.72	39.28	10.58	17.14	11.56
Salted salmon	LXII	53.48	46.52	22.68	12.19	11.65
Salted halibut (H. maximus)	LXIII	54.65	45.35	23.49	6.82	15.04
Salted great sturgeon (A. huso)	LXIV	61.85	38.15	18.70	8.93	10.52
Marinated river lamprey	LXV	44.62	55.38	34.32	16.57	4.49
Salted and smoked Pelecus vulgaris	LXVI	54.89	45.11	30.04	5.87	9.20
Salted and smoked Alburnus chalcoides	LXVII	43.53	56.47	28.83	16.21	11.43
Salted and dried roach (Leuciscus rutilus, var. caspica)	LXVIII	27.96	72.04	47.85	9.88	14.31
Dried cod	LXIX	25.23	74.77	68.88	0.69	5.20
Salted Caspian shad	LXX	59.56	40.44	22.06	8.86	9.52
Salted caviar of Coregonus species	LXXI	66.05	33.95	17.72	8.97	7.26
Fresh caviar of sturgeon	LXXII	56.97	43.03	27.87	12.85	2.31
Salted and dried Coregonus leucichthys	LXXIII	57.55	42.45	23.50	13.17	5.78
Salted and dried sturgeon	LXXIV	36.67	63.33	42.05	14.35	6.93
Dried "dorsal cords" (Vezeega)	LXXV	50.99	49.01	45.43	0.06	3.52

The following translation of part of Prof. Kostytscheff's article above referred to is interesting in its bearing upon the economic importance of fish as food and of fish-culture in Russia.

It is well known that in general our waters are comparatively rich in fish, and that a very large quantity of fish is caught there every year. In a recently published pamphlet by O. A. Grimm* the amount of fresh fish caught annually in Russia is estimated at 40,000,000 puds.†

Whoever will take the trouble to closely examine the statistical data presented in this work will find that these data are very incomplete, and that this figure of 40,000,000 puds is far below the actual number. But even this incomplete estimate will allow us to deduce some very instructive conclusions concerning the importance of fish as food in our national life. To do this, let us determine the quantity of nutritive matter derived from the fish caught and prepared in various ways in Russia. In doing this we may restrict ourselves to the consideration of the albuminous matter as the most important constituent of animal food.

*Fishing and hunting in Russian waters. (International Fisheries Exhibition.) St. Petersburg, 1883. (English).

† 1 pud = 40 Russian pounds = about 36 English pounds.

Let us first select for our calculation those more important species of fish about which Mr. Grimm's pamphlet gives definite data, and for which we also have analysis:

	Puds.
1. Pike-perch, amount sent out from Astrakhan, not less than	2,000,000
2. Salmon caught in various places, not less than	60,000
3. Smelt and spirling	1,000,000
4. Salt-dried "vòbla"	3,000,000
5. Bream, shield-fish, etc	3,500,000
6. Astrakhan herring	7,000,000
7. Sturgeon, sturgeon caviar, and balyk	1,500,000

It will be seen from Mr. Grimm's figures that this whole amount of fish (which is mostly in a preserved condition) corresponds to 25,000,000 puds of fresh fish. Consequently, the quantity of all other kinds of fish caught every year amounts to not less than 15,000,000 puds.

Assuming that in the fishes mentioned above two-thirds of the weight is flesh and one-third makes up the weight of bones, skin, etc., it will be found with the aid of the analyses given before that the amount of dry albumen obtained from these fishes is not less than 2,330,000 puds.

Assuming, further, that in the remaining 15,000,000 puds of fish the skin, scales, bones, etc., amount to one-third and the flesh to two-thirds of the total weight, and supposing all these fishes to be such as contain the least amount, 10 per cent., of albuminous matter, the amount of dry albumen obtained will be at least 1,000,000 puds.

We thus find that we annually derive from our fisheries 3,330,000 puds of albuminous matter. This estimate is certainly below the actual amount: first, because many fishes contain more than two-thirds of flesh; second, because the annual yield of the fisheries in Russia is no doubt greater than 40,000,000 puds.

At first sight this figure of 3,330,000 puds of albuminous matter may not appear very great. To better realize its true signification, let us try to calculate what resources would be required to obtain the same amount of animal albuminous substance from cattle. Let us suppose that, to replace fish as food, we keep black cattle of such kind that on an average every head when fully grown weighs 20 puds. Such an animal will contain 45.9 per cent. of flesh without bones, or 9.18 puds; and this flesh will contain 1.61 puds of albuminous matter. Now, to obtain from such black cattle 3,330,000 puds of albuminous matter annually, it will be necessary to kill not less than 2,000,000 head of cattle a year. Let us further assume that our cattle will be ready for slaughter when four years old; it will be seen that the supply of cattle in Russia would have to be increased by 8,000,000 head of cattle for slaughter and not less than 2,500,000 cows for breeding. Consequently, even under the most fortunate but impossible circumstances, such as the absence of special cattle diseases, sterility of cows, etc., the number of black cattle in Russia would have to be increased by at least 10,500,000 in order to supply these 3,500,000 puds of albumen. It would require not less than 25,000,000 *desiatin** of meadows and pastures of good quality to keep and feed these cattle. How enormous these figures are will be seen from the fact that the number of milch cows in European Russia (not including Poland and Finland) is estimated by various authors at from 5,000,000 to 10,000,000, and the area of pasturage at 55,000,000 *desiatin*.

We have however, neglected in our calculation to take into account the milk provided by the cows. Supposing that, on an average, every cow gives 60 pails or 180 pounds of milk, this milk represents 1.44 puds of albuminous matter (the average proportion of albumen in milk being 3.2 per cent.). Every cow thus furnishes nearly as much albuminous matter per year as is contained in the flesh of the full-grown animal. Taking the milk into account, our figures will therefore have to be reduced by one-half. But even then they are exceedingly high, amounting to 6,000,000 head of cattle that would require over 12,000,000 *desiatin* of meadows and pastures. Approximately, we may adopt as our final result that, in order to substi-

* One *desiatin* = about 2.7 acres.

tute the albuminous matter of the milk and flesh of our domestic animals for that obtained from our fisheries, we would have to raise the productivity of our cattle-breeding industry 10 per cent., and the supply of food for the same.

These figures define (with the degree of approximation attainable with the available statistical data) the position and rank the fisheries take in the animal food-supply of the population of Russia. It would of course be possible to replace it by the products of cattle breeding, but only with the same prices for food. But the prices for the products derived from cattle are far higher than those for the corresponding nutritive products of fish (taken on an average); 1 pud of albuminous matter of fish is worth less than 20 roubles, whereas the same amount derived from the flesh of cattle will be worth not less than 40 to 50 roubles; the latter food is therefore accessible to a smaller number of people.

It is true, however, that to replace fish by vegetable food would require very much smaller resources. To produce 3½ million puds of albuminous matter requires, for instance, only 600,000 *desiatin* of rye, assuming a yield of 55 puds per *desiatin* exclusive of seed, or not over 900,000 *desiatin* in the case of farming by triennial rotation, and neglecting the meadows necessary for obtaining manure.

ANALYSES OF EUROPEAN HADDOCK BY THE WRITER.

The haddock, of which analyses by myself are given in Tables 22 and 23, were purchased in Munich and were stated to have come from the Baltic. The methods of analysis were the same as followed in the analyses of American fishes previously described, except that the determinations of water were made in air instead of hydrogen.* The specimens consisted of flesh, nearly pure muscular tissue, freed from skin, bones, and other refuse.

TABLE 22.—*Analyses of flesh of European haddock (water-free substance).*

Specimen No.	Nitrogen.	Protein (N×6.25).	Fats (ether extract).	Ash.	Protein+fats + ash.	Albuminoids, etc., (by difference).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
LXXVI	14.91	93.19	0.61	6.37	100.17	93.02
LXXVII ..	15.36	96.00	1.83	6.12	103.95	92.05

TABLE 23.—*Analyses of flesh of European haddock (fresh substance).*

Specimen No.	Water.	Water-free substance.	Albuminoids, etc., (by difference).	Fats.	Ash.	Nitrogen.	Protein (N×6.25).	Water+protein+fat+ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
LXXVI ...	81.91	18.09	16.83	0.11	1.15	2.73	17.06	100.23
LXXVII ..	80.58	19.42	17.87	0.36	1.19	2.98	18.63	100.76

ANALYSES BY POPOFF.

Table 24 gives the analyses of Russian fishes by Dr. Popoff, quoted by Kostytscheff. The analyses are said to have been made by the same method as those of König in which "the proportion of albuminous matter is computed from the amount of nitrogen found by simply multiplying the latter by the coefficient 6.25." The determinations include

* Zeitschrift für Biologie, XXIV, 1887, 16.

only water, protein ("albuminous matters"), fat, and ash. The figures in the other columns of Table 24 are computed to the forms used in this report, as was done with the analyses of Payen, König, and others above. As already explained, these data were received after the present report had been prepared for the printer and hence can not be treated as fully as would otherwise be done.

TABLE 24.—*Analyses of Russian fishes and fish roc by Dr. Popoff (recalculated to forms used in this report).*

Names of fishes.	Reference No. of specimen.	Water.	Water-free substance.	Water-free substance. Albuminoids (by difference).	Fats.	Ash.	Protein, N × 6.25.	Water + protein + fats + ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Smelt (Osmerus eperlanus ?)	LXXVIII	79.01	20.99	13.71	4.31	2.97	13.86	100.15
"Vobla"*	LXXIX	75.76	24.24	16.76	5.88	1.60	17.29	100.53
Roe of fresh "vobia"	LXXX	72.18	27.82	20.06	6.85	0.91	19.78	99.62
PRESERVED FISH.								
Salted smelt (Osmerus eperlanus ?)	LXXXI	42.58	57.42	30.21	8.28	18.93	29.98	99.77
Smoked bream	LXXXII	37.25	62.75	36.71	15.22	10.82	36.92	100.21
Salted and dried pike perch	LXXXIII	20.55	79.45	59.91	1.92	17.62	60.33	100.42
Salted and dried spirling (smelts)	LXXXIV	72.45	27.55	17.26	6.78	3.51	16.14	98.88
Roe of smoked bream	LXXXV	33.17	66.83	42.95	16.30	7.58	42.80	99.85

* Said to be "a fish found in the Volga, the size of a crucian."

ANALYSES BY SEMPOLOWSKI.

In a paper entitled "*Untersuchungen von Seetieren auf ihren Gehalt an agrikultur-chemisch wichtigen Stoffen*,"* L. Sempolowski gives the results of analyses of fishes with a view to learning their fertilizing value. The specimens analyzed included the whole fish, except in the cases of No. 1, from which fat had been extracted, and No 5, in which separate analyses were made of the flesh and of the head and bones. The following tables are translated from the original. As no further reference is to be made to the results in the present report the numbers are not made consecutive with the previous ones.

TABLE 25.—*Analyses of fishes and fish refuse, by L. Sempolowski. (Fresh material.)*

Names of fishes.	Water.	Water-free substance.	Fat.	Ash.	Phosphoric acid.	Potash.	Lime.	Nitrogen.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1. Plaice (Pleuronectes platessa)	79.12	20.88	1.39	3.58	1.24	0.63	0.62	2.73
2. Plaice (Pleuronectes limanda)	78.32	21.68	1.75	3.45	1.25	0.47	1.25	2.79
3. Star-ray or skate (Raja radiata)	80.67	19.33	1.79	2.61	0.91	0.34	0.61	2.68
4. Haddock (Gadus aglefinus)	78.90	21.10	1.14	3.59	1.22	0.40	1.16	2.76
5. Cod (Gadus morrhua):								
(*a*) Flesh	80.61	19.39	0.37	1.57	0.61	0.60	0.11	3.00
(*b*) Head and bones	78.25	21.75	0.67	7.42	2.91	0.43	3.65	2.29
6 Gray gurnet (Trigla gurnardus)	74.59	25.41	5.31	4.47	1.78	0.70	0.97	2.70
7. Common thornhound (Acanthias vulgaris)	59.08	40.92	10.45	2.75	0.98	0.52	0.07	5.33

* Die Landw. Vers.-Stat., XXXVI, S. 61.

TABLE 26.—*Analyses of fishes and fish refuse by L. Sempolowski.* (*Air-dry material.*)

Names of fishes.	Water.	Water-free substance.	Fat.	Ash.	Phosphoric acid.	Potash.	Lime.	Nitrogen.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1. Plaice (Pleuronectes platessa)	8.76	91.24	6.07	15.65	5.42	2.75	2.71	11.96
2. Plaice (Pleuronectes limanda)	7.93	92.07	7.43	14.64	5.32	1.98	5.31	11.85
3. Star-ray or skate (Raja radiata)	8.57	91.43	8.45	12.32	4.31	1.61	2.89	12.66
4. Haddock (Gadus æglefinus)	7.68	92.32	5.00	15.70	5.32	1.75	5.09	12.06
5. Cod (Gadus morrhua):								
(*a*) Flesh	9.52	90.48	1.73	7.30	2.86	2.85	0.53	14.00
(*b*) Head and bones	8.83	91.17	2.80	31.09	12.18	1.81	15.29	9.58
6. Gray gurnet (Trigla gurnardus)	6.04	93.96	19.63	16.94	6.60	2.59	3.58	9.94
7. Common thornhound (Acanthias vulgaris)	18.91	81.09	20.71	5.46	1.95	1.03	0.14	10.56

TABLE 27.—*Analyses of fishes and fish-refuse by L. Sempolowski.* (*Water-free material.*)

Names of fishes.	Fat.	Ash.	Phosphoric acid.	Potash.	Lime.	Nitrogen.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1. Plaice (Pleuronectes platessa)	6.64	17.16	5.94	3.01	2.98	13.10
2. Plaice (Pleuronectes limanda)	8.07	15.90	5.78	2.16	5.77	12.87
3. Star-ray or skate (Raja radiata)	9.24	13.48	4.72	1.76	3.17	13.85
4. Haddock (Gadus æglefinus)	5.42	17.00	5.76	1.89	5.51	13.06
5. Cod (Gadus morrhua):						
(*a*) Flesh	1.91	8.07	3.16	3.15	0.58	15.47
(*b*) Head and bones	3.07	34.10	13.36	1.99	16.77	10.51
6. Gray gurnet (Trigla gurnardus)	20.89	17.61	7.02	2.76	3.81	10.58
7. Common thornhound (Acanthias vulgaris)	25.55	6.73	2.40	1.27	0.18	13.02

Besides the analyses above mentioned, others have been reported, but none with which I am familiar have been executed by methods making them comparable with these, or to give definite information as to the amounts of the constituents now recognized as making up the tissues of the fish. I may, however, refer to a number of earlier analyses.

One of these is *Examen Chimique de L'eperlan, Salmo eperlanus*, Morin.* This is a qualitative investigation of some of the constituents of the flesh of the smelt, of which a résumé may be found in Pereira (Food and Diet, New York, 1851, p. 132).

Brande's Manual of Chemistry, quoted by Pereira (loc. cit., p. 111), gives the composition of the muscles of various animals, including cod, haddock, and sole, but regards the nutritive matter (water-free substance) as made up of albumen or fibrin and gelatin, exclusively, and takes no account of the fat or other ingredients.

Schlossberger † gives the composition of the muscular flesh of carp and trout, with that of other animals. His table is quoted by Pereira along with that of Brande just named. No account is taken of the fats.

The analysis of *Leuciscus rutilus* by Limpricht ‡ will be referred to

* Journal de Pharmacie VIII, 1822, p. 61.

† Valentine's Report, 1841, 294, and Pharmaceutisches Central-blatt 1842, 41.

‡ Liebig's Annaler, CXXVII, 1863, 185.

in the discussion of the constitution of the flesh of fishes in another place, as will Christison's statement regarding the composition of clean and foul salmon.*

Various other chemists have studied the composition of the flesh and other organs of fishes, but the purposes and methods have been such that the results need not be referred to in detail here. I should, however, call attention to an article by Dr. Davy,† in which the attempt is made to compare the nutritive values of different fishes by their percentages of dry substance.

PROPORTIONS OF PROTEIN IN THE FLESH OF FISHES.

In the recapitulations of European analyses of the flesh of fishes the percentage of protein as estimated by multiplying the percentages of nitrogen by the factors 6.25, the percentages of "albuminoids" as estimated by difference, and the footings, water+protein+fats+ash, are given where the data permit. One object in this has been to obtain a crude test of the correctness of the analyses, it being assumed that a wide divergence between the figures for nitrogenous material by the two methods or, what is the same thing, a wide divergence between the sums named and 100, would indicate error of analysis. Doubtless some of the wider divergences in the analyses here cited are due to typographical errors. But considering the fact that even the directions for determining nitrogen by the soda-lime method as found in standard works on quantitative analysis are such as to involve danger of serious error, and that numerous analysts in following them have been unable to obtain reliable results, it would not be strange if errors in the nitrogen determinations had crept into some of the earlier analyses. My experience has also warned me that the dangers of error in the determinations of water and fats are greater than is sometimes supposed.

The object of these remarks is not to criticise the most valuable work of the investigators whose results are quoted, but rather to enforce the need of improvement of the analytical methods. Meanwhile the figures for albuminoids by difference perhaps represent the actual quantities of nitrogenous material more nearly than those obtained by multiplying the nitrogen by 6.25. They are used in the tables beyond, in which the analyses are summarized.

* Cited by Smith, Foods, p. 108.

† Edinburgh New Philosophical Journal, Oct. 1853, p. 225; Dingler's Polyt. Journal, 131, 1854, p. 390.

3. ANALYSES OF ROE, CAVIAR, AND THE LIVER OF FISHES.

ANALYSES OF ROE, CAVIAR, ETC.

Payen gives an analysis of caviar;* König and Brimmer one of caviar;† Lidow one of "fresh granular caviar" and one of "paionsnaja," a strongly salted and pressed caviar;‡ von Kletzinski one of "fischrogenkase," prepared by fishermen of the Dardanelles by drying the roe of certain fish in air and pressing;§ and Stutzer one of Russian caviar.¶ The analyses by Kostytscheff (Tables 20 and 21) above include one of "salted caviar of *Coregonus*, sp., No. LXXI, and one of "fresh caviar (roe?) of sturgeon, No. LXXII. Those of Popoff (Table 24) include one of "roe of vobla," No. LXXX, and one of "roe of smoked bream," No. LXXXV. With the analyses of the flesh of American fishes, previously given, a specimen of fresh roe of shad was made. It was from shad No. 245 and is numbered 246. These analyses are collated in Table 31, in which the results are, in so far as the data permit, calculated to the forms used here.

The analyses of eggs of carp by Gobley ‖ were made by different methods and for a different purpose from these, and would hardly be in place here.

TABLE 28.—*Analyses of roe, caviar, etc.*

[The roe of shad is American, the rest are European.]

Kinds of fish, etc.	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids, etc., by difference.	Fats.	Ash.	Non-nitrogenous extractive matters.	Protein, N ×6.25.	Water + protein + fats+ash.
Roe of shad, fresh	246	71.25	28.75	23.44	3.78	1.53	(2.56)	20.88	97.44
Fresh caviar (roe?) of sturgeon	LXXII	56.97	43.03	27.87	12.85	2.31			
Roe of fresh vobla (Popoff)	LXXXIV	72.18	27.82	20.06	6.85	0.91			
Salted caviar of *Coregonus*, sp	LXXI	66.05	33.95	17.72	8.97	7.26			
Caviar (Payen)	LXXXVI	37.50	62.50	36.96	16.26	9.28	(7.82)	28.04	91.08
Caviar (König and Brimmer)	LXXXVII	45.04	54.96	31.91	14.14	8.91	......	31.90	99.99
Caviar, fresh, granular (Lidow)	LXXXVIII	53.84	46.16	25.18	13.12	7.86	......	25.18	100.00
Caviar, Russian (Stutzer)	LXXXIX	52.16	47.84	27.86	15.45	4.53	......	28.02	100.16
Average 5 specimens caviar	....	50.92	49.08	27.92	13.59	7.57			
"Roe of smoked bream"	XC	33.17	66.83	42.95	16.30	7.58	......	42.80	99.85
"Paionsnaja" (Lidow)	XCI	30.89	69.11	40.33	18.90	9.88	......	40.33	100.00
"Fischroggenkäse" (Kletzinski)	XCII	19.38	80.62	41.14	28.87	10.61	(6.33)	34.81	93.67

*Compt. rend., 39, 318, quoted by König, Nahrungsmittel, 3te, Aufl. I, 217. † König, loc. cit. ‡ Chem. Zeit'g., 1880, 818, quoted by König. § Jbt. d. Chem., 1865, 836. ¶ Repertorium der Anal. Chem., II, 1882, 168. ‖ Jour. d. Pharm. (3), 17, 401, and 18, 411.

THE LIVER OF FISHES.

König (Nahrungsmittel, 1, 18) cites from Moleschott (Physiologie, der Nahrungsmittel, 1859), analyses by von Bibra of liver of pike, trout, and carp. The percentage of protein, as given in each case, is 6¼ times that of nitrogen, and the percentages of water, protein, fat, ash, and "non-nitrogenous extractives," together make 100; hence I infer that the last are estimated by the difference. The figure for the amount of these substances in No. XCVI is noticeably large. These analyses, with one of liver of burbot by Kostytscheff, taken from Table 21, are put together in Table 32. As above explained, non-nitrogenous extractives are given in the analysis of the liver of burbot.

Analyses of oil in fish of different species may be found in König, Nahrungsmittel, 3te Aufl., p. 218.

TABLE 29.—*Analyses of the liver of fishes.*

Liver of—	Reference No. of specimen.	Water.	Water-free substance.	Protein.	Fat.	"Non-nitrogenous extractives.	Ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Pike, (v. Bibra)	XCIII	79.34	20.66	6.66	4.73	7.61	1.64
Trout, (v. Bibra)	XCIV, XCV	78.64	21.36	16.05	3.00	0.42	1.89
Carp, (v. Bibra)	XCVI	68.06	31.94	14.37	2.93	13.49	1.15
Burbot, (Kostytscheff)	LIX	45.58	54.42	8.92	44.89	(?)	0.61

SECTION C.—COMPOSITION OF AMERICAN AND EUROPEAN FISHES COMPARED.

1. RECAPITULATION OF ANALYSES OF AMERICAN AND EUROPEAN FISHES.

GENERAL STATEMENT.

The analyses recounted in the previous chapters include all that I am familiar with of American and European fishes made in accordance with the methods now current. They are summarized in the forms adopted in the present report, in Tables 30, 31, and 32. Of these, not much need be said by way of explanation, except that the analyses of a few of the European specimens, particularly of preserved fish, have been omitted, either because they were of so unusual occurrence that a repetition of the statements of the analyses is hardly necessary, or because of apparent errors in the reports to which I have had access. I believe that these tables contain all the analyses that are most important for our present purpose.

Table 30 recapitulates the analyses of the flesh of specimens of fresh fish. It will be observed that the albuminoids, etc., are estimated by difference, but that the percentages of protein ($N \times 6.25$) are also given. When a number of analyses of the same species were made the maxi-

mum and minimum percentages of each constituent and the averages of all the analyses are given.

Table 31 gives corresponding analyses of the flesh of preserved fish. The percentage of salt, sodium chloride, is usually given separately, though in some cases the analyst reported the two together, and in consequence no distinction is made here.

Table 32 gives the percentages of proximate ingredients as directly determined. I have regarded it as worth while to put these analyses together, though, as was stated in discussing the subject in the previous chapters, the methods of analysis are incomplete and the results not entirely satisfactory. It is to be further noted that the American analyses were all made of the flesh freed from skin, while part, and I presume nearly all, of the specimens of the European analyses included both flesh and skin. In some if not all of the European analyses the insoluble albuminoids were determined by difference.

So few of the reports of European analyses include statements of the composition of the fish as found in the markets, including both flesh and refuse matters, that a table summarizing the European and American analyses on this basis, as was done with the American analyses in Table 9, seems hardly necessary here, especially as such a compilation is to be given in one of the chapters beyond (Part II) on the economic application of the analyses.

TABLE 30.—*Recapitulation of analyses of flesh of specimens of American and European fishes.*

["Albuminoids," etc., estimated by difference. "Protein" estimated by multiplying nitrogen by 6.25. By "maximum" and "minimum" are to be understood, in each case, the largest and smallest percentages of each ingredient found in any of the specimens of the species.]

Names of fishes. (A, American; E. European.)	No. of specimens analyzed.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats.	Ash.	Protein (N×6.25).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sturgeon (Acipenser sturio), A	1	78.71	21.29	17.96	1.90	1.43	18.11
Sturgeon (Acipenser güldenstædtii), E	1	76.02	23.98	17.67	5.15	1.16	.....
Sterlet (Acipenser ruthenus), E	1	76.81	23.19	16.64	5.59	0.96	.....
Small-mouthed red-horse (Moxostoma velatum), A	1	78.56	21.44	17.90	2.35	1.19	17.99
Carp (Cyprinus carpio), E:							
Maximum	....	79.89	23.03	20.60	1.42	1.34	.....
Minimum	....	76.97	20.11	17.55	1.09	1.14	.....
Average	2	78.43	21.57	19.07	1.26	1.24	*21.86
Crucian carp (Carassius vulgaris), E	1	80.82	19.18	17.63	0.48	1.07	.....
Barbel? (Barbus vulgaris ?), E	1	89.35	10.65	9.54	0.21	0.90	9.82
Gudgeon (Gobio fluviatilis), E	1	76.89	23.11	16.99	2.68	3.44	17.37
Bleak (Alburnus lucidus), E	1	72.89	27.11	15.73	8.13	3.25	16.81
Herring (Clupea harengus), A and E:							
Maximum	....	76.11	30.97	19.23	11.01	1.90	19.12
Minimum	....	69.03	23.89	17.29	4.89	1.50	15.31
Average	4	72.10	27.90	18.19	8.02	1.69	*17.75
Alewife (Clupea vernalis), A:							
Maximum	....	75.92	27.04	19.54	6.02	1.48	19.72
Minimum	....	72.96	24.08	18.80	3.82	1.46	19.00
Average	2	74.44	25.56	19.17	4.92	1.47	19.36
Shad (Clupea sapidissima), A:							
Maximum	....	73.56	34.75	19.98	13.59	1.54	20.10
Minimum	....	65.25	26.44	17.83	6.51	0.90	18.08
Average	7	70.62	29.38	18.55	9.48	1.35	18.80

* Of less than all the analyses.

TABLE 30.—*Recapitulation of analyses of flesh of specimens of American and European fishes*—Continued.

Names of fishes. (A, American; E, European.)	No. of specimens analyzed.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats.	Ash.	Protein (N × 6.25).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Smelt (Osmerus mordax), A:							
Maximum	....	80.16	21.84	18.83	1.94	2.00	18.65
Minimum	....	78.16	19.84	15.90	1.65	1.36	16.52
Average	2	79.16	20.84	17.36	1.80	1.68	17.58
Smelt (Osmerus eperlanus), E	1	78.38	21.62	16.97	3.08	1.57	......
Whitefish (Coregonus clupeiformis), A	1	69.83	30.17	22.06	6.49	1.62	22.93
Whitefish (Coregonus bærii), E	1	79.13	20.87	18.12	1.53	1.22	......
Cisco, Coregonus sp. (tullibee or artedi?), A	1	76.15	23.85	19.12	3.48	1.25	19.26
California salmon (Oncorhynchus chouicha), A:							
Maximum	....	64.53	37.32	17.96	19.25	1.11	......
Minimum	....	62.68	35.47	16.96	16.50	1.01	......
Average	2	63.61	36.39	17.46	17.87	1.06	*18.56
Salmon (Salmo salar), A and E:							
Maximum	....	75.70	38.97	24.45	14.99	1.56	24.77
Minimum	....	61.03	24.30	18.06	4.85	1.10	13.09
Average	8	65.76	34.24	20.77	12.09	1.38	20.51
Spent salmon (Salmo salar), A:							
Maximum	....	78.20	24.73	19.24	4.37	1.17	19.15
Minimum	....	75.27	21.80	17.80	2.83	1.12	17.62
Average	2	76.74	23.26	18.52	3.60	1.14	18.38
Spent landlocked salmon (Salmo salar, subsp. sebago), A:							
Maximum	....	79.20	22.12	17.65	4.01	1.27	17.24
Minimum	....	77.88	20.80	16.84	1.95	1.20	16.18
Average	2	78.54	21.46	17.24	2.98	1.24	16.71
Lake trout (Salvelinus namaycush), A:							
Maximum	....	75.35	31.22	19.12	12.55	1.35	19.42
Minimum	....	68.78	24.65	17.32	10.21	1.17	17.62
Average	2	69.14	30.86	18.22	11.38	1.26	18.52
Salmon trout (Salmo trutta), E	1	75.35	24.65	20.83	2.49	1.33	......
Brook trout (Salvelinus fontinalis), A:							
Maximum	....	79.84	24.22	20.03	2.94	1.42	20.30
Minimum	....	75.78	20.16	18.43	0.75	0.96	18.60
Average	3	77.72	22.28	18.97	2.10	1.21	19.23
Pickerel (Esox reticulatus), A:							
Maximum	....	79.84	20.48	18.88	0.52	1.24	19.02
Minimum	....	79.52	20.16	18.40	0.49	1.11	18.43
Average	2	79.68	20.32	18.64	0.50	1.18	18.73
Pike (Esox lucius), A and E:							
Maximum	....	83.89	22.47	20.58	0.60	1.29	*20.36
Minimum	....	77.53	16.11	14.83	0.15	1.03	*14.81
Average	4	80.48	19.52	17.95	0.41	1.16	*17.95
Muskellunge (Esox nobilior), A	1	76.26	23.74	19.63	2.54	1.57	20.15
Eel (Anguilla rostrata), A and E:							
Maximum	....	73.40	47.22	18.95	32.88	1.11	19.25
Minimum	....	52.78	26.60	13.29	7.88	0.77	12.50
Average	4	64.51	35.49	15.82	18.74	0.93	15.67
Conger eel (Conger vulgaris), E	1	79.91	20.09	13.96	5.02	1.11	13.58
Mullet (Mugil albula), A	1	74.87	25.13	19.32	4.64	1.17	19.48
Mackerel (Scomber scombrus), A and E:							
Maximum	....	78.67	35.99	23.11	16.41	1.85	23.42
Minimum	....	64.01	21.33	17.42	2.20	1.00	17.51
Average	8	71.62	28.38	18.77	8.21	1.40	19.45
Spanish mackerel (Cybium maculatum), A	1	68.10	31.90	20.97	9.43	1.50	21.45
Pompano (Trachynotus carolinus), A:							
Maximum	....	78.18	32.62	19.15	13.51	1.03	19.30
Minimum	....	67.38	21.82	18.15	1.64	0.96	18.35
Average	2	72.78	27.22	18.65	7.57	1.00	18.83
Bluefish (Pomatomus saltatrix), A	1	78.46	21.54	19.02	1.25	1.27	19.41
Butterfish (Stromateus triacanthus), A	1	70.02	29.98	17.81	11.03	1.14	17.99
Large-mouthed black bass (Micropterus salmoides), A	1	78.61	21.39	19.24	0.96	1.19	19.44
Small-mouthed black bass (Micropterus dolomieu), A	1	74.82	25.18	21.50	2.44	1.24	21.71
Yellow perch (Perca fluviatilis), A and E:							
Maximum	....	80.43	21.93	19.47	1.12	1.38	19.69
Minimum	....	78.07	19.57	17.88	0.44	1.14	17.79
Average	3	79.52	20.48	18.49	0.70	1.29	18.53
Wall-eyed pike (Stizostedion vitreum), A	1	79.74	20.26	18.42	0.47	1.37	18.58
Gray pike (Stizostedion canadense), A	1	80.85	19.15	17.26	0.76	1.13	17.88
Pike perch (Stizostedion sandra), E	1	79.87	20.13	18.93	0.20	1.00	......
Striped bass (Roccus lineatus), A:							
Maximum	....	79.63	24.24	19.33	4.61	1.36	19.54
Minimum	....	75.76	20.37	16.87	1.56	0.92	17.06
Average	6	77.70	22.30	18.31	2.83	1.16	18.54

* Of less than all the analyses.

TABLE 30—*Recapitulation of analyses of flesh of specimens of American and European fishes*—Continued.

Names of fishes. (A, American; E, European.)	No. of specimens analyzed.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats.	Ash.	Protein (N ×6.25).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
White perch (Roccus americanus), A:							
Maximum	....	75.77	24.36	20.43	5.62	1.28	20.58
Minimum	..	75.64	24.23	17.63	2.52	1.11	17.95
Average	2	75.71	24.29	19.03	4.07	1.19	19.27
Sea bass (Centropristris atrarius), A	1	79.32	20.68	18.75	0.49	1.44	19.84
Grouper (Epinephelus morio), A:							
Maximum	....	79.95	21.04	19.19	0.71	1.16	19.81
Minimum	....	78.96	20.05	18.41	0.48	1.14	18.63
Average	2	79.45	20.55	18.80	0.60	1.15	19.22
Red Snapper (Lutjanus blackfordi), A:							
Maximum	....	79.81	22.66	19.89	1.94	1.34	20.17
Minimum	....	77.34	20.19	18.34	0.54	1.27	19.26
Average	3	78.46	21.54	19.20	1.03	1.31	19.72
Porgy (Diplodus argyrops), A:							
Maximum	....	79.68	28.02	19.29	7.86	1.40	19.43
Minimum	....	71.98	20.32	17.46	1.46	1.35	17.44
Average	3	74.99	25.01	18.52	5.11	1.38	18.58
Sheepshead (Diplodus probatocephalus), A:							
Maximum	....	79.08	27.99	20.17	6.72	1.33	20.82
Minimum	....	72.01	20.92	18.93	0.66	1.10	19.36
Average	2	75.55	24.45	19.54	3.69	1.22	20.08
Red bass (Sciæna ocellata), A	1	81.56	18.44	16.68	0.53	1.23	16.88
Kingfish (Menticirrus nebulosus), A	1	79.21	20.79	18.66	0.95	1.18	18.94
Weakfish (Cynoscion regale), A	1	78.97	21.03	17.45	2.39	1.19	17.80
Blackfish (Hiatula onitis), A:							
Maximum	....	81.36	23.05	18.96	2.81	1.36	19.33
Minimum	....	76.95	18.64	17.44	0.55	0.65	17.61
Average	4	79.10	20.90	18.47	1.35	1.08	18.70
Hake (Phycis chuss), A	1	83.11	16.89	15.24	0.67	0.98	15.37
Cusk (Brosmius brosme), A	1	82.01	17.99	16.92	0.17	0.90	17.00
Haddock (Gadus æglefinus), A and E:							
Maximum	....	82.56	19.70	18.38	0.36	1.64	18.63
Minimum	....	80.30	17.44	15.94	0.11	1.03	16.32
Average	8	81.39	18.61	17.10	0.26	1.25	17.36
Cod (Gadus morrhua), A and E:							
Maximum	....	83.48	19.29	17.80	0.51	1.44	*18.32
Minimum	....	80.71	16.52	14.95	0.07	1.00	*15.49
Average	7	82.46	17.54	16.00	0.30	1.24	*16.54
Russian cod (Gadus navaga), E	1	81.35	18.65	16.48	0.59	1.58	......
Whiting (Gadus merlangus), E	1	82.95	17.05	15.59	0.38	1.08	15.10
Tomcod (Gadus tomcod), A	1	81.55	18.45	17.08	0.38	0.99	17.24
Pollock (Gadus virens), A	1	76.02	23.98	21.65	0.78	1.55	21.60
Halibut (Hippoglossus vulgaris), A:							
Maximum	....	79.15	29.87	19.40	10.57	1.15	19.68
Minimum	....	70.13	20.85	17.49	2.21	0.88	17.53
Average	3	75.42	24.58	18.35	5.18	1.05	18.58
Turbot (Platysomatichthys hippoglossoides), A	1	71.39	28.61	12.92	14.41	1.28	14.75
Common flounder (Paralichthys dentatus), A:							
Maximum	....	85.04	16.63	14.73	0.77	1.29	14.91
Minimum	....	83.37	14.96	12.90	0.62	1.28	13.22
Average	2	84.21	15.79	13.82	0.69	1.28	14.07
Winter flounder (Pleuronectes americanus), A	1	84.35	15.65	14.01	0.44	1.20	14.53
Plaice (Pleuronectes platessa), E	1	77.39	22.61	19.35	1.80	1.46	19.99
Dab (Pleuronectes limanda), E	1	79.41	20.59	16.59	2.06	1.94	18.11
Sole (Solea vulgaris), E	1	86.14	13.86	12.38	0.25	1.23	11.94
Lamprey eel (Petromyzon marinus?), A	1	71.12	28.88	14.93	13.29	0.66	14.98
Skate (Raia sp.), A and E:							
Maximum	....	82.15	24.50	22.32	1.39	1.71	24.04
Minimum	....	75.50	17.85	15.32	0.47	1.14	18.17
Average	2	78.82	21.18	18.82	0.93	1.43	21.10

* Of less than all the analyses.

TABLE 31.—*Recapitulation of analyses of flesh of preserved fish, American and European specimens.*

[By "Maximum" and "Minimum" are to be understood in each case the largest and smallest percentages of each ingredient found in any of the specimens of the same species.]

Kinds of preserved fish. (A, American; E, European.)	No. of specimens analyzed.	Water.	Water-free substance.	Albuminoids, etc., by difference.	Fats.	Ash.	Salt (sodium chloride).	Protein (N×6.25).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Salt sturgeon (Acipenser huso), E	1	61.85	38.15	18.70	8.93	0.49	10.03	....
Salted and smoked Pelecus vulgaris, E	1	54.89	45.11	30.04	5.87	1.21	7.99	....
Salted and smoked bleak (Alburnus chalcoides), E	1	43.53	56.47	28.83	16.21	1.57	9.86	....
Salted and dried roach (Leuciscus rutilus var. caspica), F	1	27.96	72.04	18.26	9.88	5.39	8.92	....
Smoked herring, salted (Clupea harengus), A	1	34.55	65.45	36.44	15.82	1.53	11.66	36.94
Smoked and pickled (?) herring (Bücklinge) (Clupea harengus), E	1	69.49	30.51	20.76	8.51	1.24	......	21.12
Salt herring (Clupea harengus), E:								
Maximum	....	55.62	57.43	21.85	21.30	2.10	16.24	19.45
Minimum	...	42.57	44.38	18.97	7.05	1.69	13.65	18.28
Average	4	48.58	51.42	20.17	14.44	1.90	14.91	19.02
Smoked sprat (Clupea sprattus), E	1	59.89	40.11	23.71	15.94	0.46	......	22.73
Smoked anchovy (Engraulis encrasicholus), E	1	51.77	48.23	22.75	2.21	2.68	20.59	22.30
Salted Caspian shad (Clupea caspica), E	1	59.56	40.44	22.06	8.86	0.54	8.98	.....
Marinated shad (Clupea meletta), E	1	60.72	39.28	10.58	17.14	[illegible]	9.90	.....
Salted and dried smelt (Osmerus spirinchus), E	1	47.12	52.88	26.38	8.03	5.33	13.14	.....
Salted and dried backs of Stenodus (Coregonus) leucichthys, E	1	57.55	42.45	23.50	13.17	1.65	4.13	.....
Salted salmon (Salmo salar), E	1	53.48	46.52	22.68	12.19	0.44	11.21	.....
Smoked and salted salmon (Salmo salar), E:								
Maximum	....	51.89	48.96	27.00	12.00	1.45	13.81	26.00
Minimum	....	51.04	48.11	22.26	11.72	0.89	7.94	22.38
Average	2	51.47	48.53	24.63	11.86	1.17	10.87	24.19
Salt mackerel (Scomber scombrus), A:								
Maximum	....	43.62	57.81	22.06	27.94	2.67	11.16	21.14
Minimum	...	42.19	56.38	16.86	22.59	2.5[illegible]	9.44	16.60
Average	3	43.01	56.99	18.88	25.12	2.59	10 40	18.55
Salt mackerel (Scomber scombrus), E	1	48.43	51.57	21.20	14.10	1.77	14.50	20.82
Smoked haddock (Gadus æglefinus), A	1	72.56	27.44	23.68	0.17	1.53	2.06	23.29
Do (canned)	1	68.73	31.27	21.78	2.25	1.65	5.59	22.29
Desiccated cod (Gadus, sp.?), A	1	15.25	84.75	74.56	1.90	5.41	2.88	77.97
Salt desiccated cod (Gadus, sp.?), A	1	11.65	88.35	71.62	4.89	5 24	6.60	72.02
Salt cod (Gadus, sp.?), A:								
Maximum	....	53.62	46.46	22.18	0 44	1.64	23.37	26.25
Minimum	....	53.54	46.38	21.17	0.25	1.59	22.71	24.87
Average	2	53.58	46.42	21.67	0.34	1.62	23.04	25.66
Dried cod, "Fischmehl" (Gadus morrhua?), E	1	17.02	82.98	73.55	0.70	8.73		76.06
Stockfish (Pollock?), E	1	13.71	86.29	78.20	1.20	6.89		79.94
Dried cod (Gadus morrhua?), E	1	25.23	74.77	68.88	0.69	4.00	1.20	....
Stockfish (Dried cod) (Gadus morrhua?), E	1	18.60	81.40	79.52	0.36	1.52	......	77.90
Salt stockfish (Gadus morrhua?), E	1	47.03	52.97	31.27	0.38	1.77	19.55	31.39
Dried ling (Gadus molva?), E	1	28.53	71.47	59.08	0.57	2.74	9.08	59.12
Salt ling (Gadus molva?), E	1	52.42	47.58	27.43	0.40	1.75	18.00	28.60
Salted, smoked, and dried halibut (Hippoglossus hippoglossus), A:								
Maximum	....	51.06	52.30	23.00	15.61	2.13	13.05	23.01
Minimum	....	47.70	48.94	18.15	14.44	1.99	12.87	18.49
Average	2	49.38	50.62	20.57	15.03	2.06	12.96	20.75
Salt halibut (Hippoglossus maximus), E	1	54.65	45.35	23.49	6.82	1.27	13.77	.....
Marinated Lamprey eel (Petromyzon, sp.?), E:								
Maximum	...	51.21	55.38	34.32	25.59	1.16	3.33	.....
Minimum	....	44.62	48.79	21.79	16.57	1.41	......	.....
Average	2	47.92	52.08	28.05	21.08	1.29	1.66	20.18
Canned sardines (Clupea pilchardus?), E	1	56.37	43.63	25.31	12.71	5.61		24.87
Canned salmon (Oncorhynchus chouicha), A:								
Maximum	....	65.86	42.45	21.29	21.49	1.35	2.19	21.06
Minimum	....	57.55	34.14	19.20	11.06	1.26	0.41	19.47
Average	3	61.88	38.12	20.06	15.70	1.32	1.04	20.18
Canned mackerel (Scomber scombrus), A	1	68.18	31.82	19.91	8.68	1.30	1.93	19.63
Canned tunny, "Horse mackerel" (Orcynus secundi-dorsalis?), A	1	72.74	27.26	21.52	4.05	1.69	......	21.67

TABLE 32.—*Recapitulation of analyses of specimens of flesh of American and European fishes.*

[Proximate ingredients as directly determined.]

Names of fishes. (A, American; E, European.)	No. of specimens analyzed.	Water.	Extractive matters.	Gelatin.	Soluble albuminoids.	Insoluble albuminoids.	Fats.	Ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sturgeon (Acipenser güldenstædtii), E	1	76.02	3.05	1.58	13.04		5.15	1.16
Sterlet (Acipenser ruthenus), E	1	76.81	1.69	1.74	13.21		5.59	0.95
Carp (Cyprinus carpio), E	1	79.89	3.92	2.84	10.79		1.42	1.14
Crucian carp (Carassius vulgaris), E	1	80.82	4.56	3.63	9.44		0.48	1.07
Herring (Clupea harengus), A	1	69.03	1.40	2.93	1.62	......	11.01	1.50
Herring (Clupea harengus), E (average)	2	74.68	2.42	1.91	13.93		5.38	1.68
Shad (Clupea sapidissima), A	1	70.75	1.92	1.93	1.92	12.74	10.08	1.34
Smelt (Osmerus mordax), A	1	80.16	3.22	4.97	0.60	7.44	1.94	2.00
Smelt (Osmerus eperlanus), E	1	78.38	4.14	2.83	10.00		3.08	1.57
Sigg (Coregonus baerii), E	1	79.13	2.93	3.70	11.69		1.53	1.22
Salmon (Salmo salar), A (average)	1	62.68	1.81	1.77	1.57	11.95	19.25	1.11
Salmon (Salmo salar), E	2	66.18	2.42	3.29	13.69		12.47	1.40
Salmon (Salmo salar), spent, A (average)	2	76.74	1.82	2.71	1.08	......	3.60	1.15
Spent land-locked salmon (Salmo salar, subsp. sebago), A (average)	2	78.54	2.11	2.09	0.86	......	2.98	1.24
Salmon trout (Salmo trutta) E	1	75.35	3.11	1.71	16.01		2.49	1.33
Brook trout (Salvelinus fontinalis) A	1	77.54	2.57	2.22	1.80	12.52	2.61	1.42
Pike (Esox lucius), E (average)	2	82.29	2.50	3.07	10.69		0.24	1.16
Muskellunge (Esox nobilior), A	1	76.26	2.27	2.40	1.65	13.46	2.54	1.57
Eel (Muræna anguilla), E	1	52.78	1.78	2.04	1.46	8.14	32.88	0.92
Mackerel (Scomber scombrus), A	1	74.14	2.22	1.48	1.88	12.25	6.99	1.30
Mackerel (Scomber scombrus), E	1	64.43	1.87	1.01	2.74	11.84	16.41	1.70
Spanish mackerel (Cybium maculatum), A	1	68.10	2.22	2.94	1.25	......	9.43	1.50
Black bass (Micropterus salmoides), A	1	78.61	2.24	3.10	2.04	......	0.96	1.19
Yellow perch (Perca fluviatilis), E	1	80.06	1.76	3.74	3.61	9.01	0.44	1.38
Wall-eyed pike (Stizostedion vitreum), A	1	79.74	2.66	3.44	1.19	10.57	0.47	1.37
Pike perch (Stizostedion sandra), E	1	79.87	3.28	3.55	12.10		0.20	1.00
White perch (Roccus americanus), A (average)	2	75.71	1.94	2.98	2.08	......	4.07	1.20
Red snapper (Lutjanus blackfordi), A (average)	2	77.78	1.83	3.27	1.72	12.98	1.28	1.30
Porgy (Diplodus argyrops), A	1	71.98	1.78	2.07	2.98	12.44	7.86	1.35
Sheepshead (Diplodus probatocephalus), A	1	72.01	1.44	3.36	1.99	11.76	6.72	1.10
Blackfish (Hiatula onitis), A	1	76.95	1.72	3.64	2.61	11.76	2.81	1.28
Haddock (Gadus æglefinus), A	1	82.03	1.11	2.94	1.42	11.70	0.14	1.57
Cod (Gadus morrhua), E (average)	2	82.00	2.52	3.46	10.61		0.14	1.27
Russian cod (Gadus navaga), E	1	81.35	4.99	2.46	9.03		0.59	1.58
Turbot (Platysomatichthys hippoglossoides), A	1	71.39	2.01	3.69	0.12	8.05	14.41	1.28
Flounder (Paralichthys dentatus), A	1	85.04	1.91	3.60	0.98	......	0.77	1.29
Plaice (Pleuronectes platessa), E	1	77.39	2.15	3.17	1.72	12.31	1.80	1.46
PRESERVED FISH.								
Salt sturgeon (Acipenser huso), E	1	61.85	1.83	2.05	14.82		8.93	10.52
Sturgeon, salted and dried backs, E	1	36.67	8.34	2.63	31.08		14.35	6.93
Dried dorsal cords, E	1	50.99	5.21	40.04	0.18		0.06	3.52
Salted and smoked Pelecus vulgaris, E	1	54.89	5.42	6.14	18.48		5.87	9.20
Salted and smoked bleak (Alburnus chalcoides), E	1	43.53	6.37	3.47	18.99		16.21	11.43
Salted and dried roach (Leuciscus rutilus, var. caspica), E	1	27.96	9.44	8.23	30.18		9.88	14.31
Salt herring (Clupea harengus), E (average)	2	49.59	4.17	1.84	1.36	12.56	14.18	16.79
Smoked herring (Clupea harengus), A	1	34.55	8.53	5.13	0.32	21.69	15.82	13.19
Marinated shad (Meletta vulgaris), E	1	60.72	3.73	3.06	3.79		17.14	11.56
Salted Caspian shad (Clupea caspica), E	1	59.56	3.78	4.87	13.41		8.86	9.52
Salted and dried smelt (Osmerus spirinchus), E	1	41.12	3.56	2.27	20.55		8.03	18.47
Salted and dried backs of Coregonus leucichthys, E	1	57.55	3.99	4.59	14.91		13.17	5.78
Canned salmon (Oncorhynchus chouicha), A	1	65.86	4.85	1.80	.....	14.49	11.06	1.79
Salted salmon (Salmo salar), E (average)	2	52.26	3.49	3.25	15.73		12.09	13.18
Salt mackerel (Scomber scombrus), A	1	42.19	3.57	1.68	0.29	15.49	22.59	13.16
Salt mackerel (Scomber scombrus), E	1	48.43	2.74	1.50	1.28	15.68	14.10	16.27
Desiccated cod (Gadus morrhua), E	1	17.02	9.14	10.47	3.38	50.56	0.70	8.73
Dried cod (Gadus morrhua), E	1	25.23	5.21	13.23	50.44		0.69	5.20
Salt cod (Gadus morrhua), A (average)	3	53.84	1.96	3.73	0.77	15.76	0.34	24.15
Dried pollock (Gadus virens), E	1	13.71	6.48	12.35	5.36	54.01	1.20	6.89
Salted ling (Gadus molva), E	1	52.42	3.70	7.06	0.60	16.07	0.40	19.75
Dried ling (Gadus molva), E	1	28.53	4.90	13.72	1.86	38.60	0.57	11.82
Smoked halibut (Hippoglossus hippoglossus), A	1	51.06	2.74	1.58	0.74	13.01	15.61	15.18
Salt halibut (Hippoglossus maximus), E	1	54.65	5.57	1.09	16.83		6.82	15.04
Marinated Lamprey eel (Petromyzon fluviatilis)	1	44.62	2.70	4.05	27.57		16.57	4.49

2. CLASSIFICATION OF SPECIMENS OF AMERICAN AND EUROPEAN FISHES ANALYZED BY THEIR CHEMICAL COMPOSITION.

In the following tabular statements the specimens of American and European fishes are classified by the composition of the flesh in the same manner as was done with the American specimens in a preceding chapter. A repetition of the explanations there made seems unnecessary.

Classification of American and European fishes by proportions of water-free substances in flesh of specimens analyzed.

[A, American; E, European.]

Kinds of fish.	No. of specimens analyzed.	Water-free substance.
Containing over 30 per cent. of water-free substance.		
California salmon, A	2	36.4
Eel, A and E	4	35.5
Salmon, A and E	8	34.2
Spanish mackerel, A	1	31.9
Lake trout, A	2	30.9
Whitefish, A	1	30.2
Containing between 30 and 25 per cent., inclusive, of water-free substance.		
Butter-fish, A	1	29.9
Shad, A	7	29.4
Lamprey eel, A	1	28.9
Turbot, A	1	28.6
Mackerel, A and E	8	28.4
Herring, A and E	4	27.9
Pompano, A	2	27.2
Bleak, E	1	27.1
Alewife, A	2	25.6
Small-mouthed black bass, A	1	25.2
Mullet, A	1	25.1
Porgy, A	3	25.0
Containing between 25 and 20 per cent. of water-free substance.		
Salmon trout, E	1	24.7
Halibut, A	3	24.6
Sheepshead, A	2	24.5
White perch, A	2	24.3
Pollock, A	1	23.9
Sturgeon, E	1	23.9
Cisco, A	1	23.8
Muskellunge, A	1	23.7
Sterlet, E	1	23.2
Gudgeon, E	1	23.1
Plaice, E	1	22.6
Striped bass, A	6	22.3
Brook trout, A	3	22.3
Smelt, E	1	21.6
Carp, E	2	21.6
Containing between 25 and 20 per cent. of water-free substance—Cont'd.		
Red snapper, A	3	21.5
Bluefish, A	1	21.5
Large-mouthed black bass, A	1	21.4
Small-mouthed red-horse, A	1	21.4
Sturgeon, A	1	21.3
Skate, A and E	2	21.2
Weakfish, A	1	21.0
Blackfish, A	4	20.9
Whitefish, E	1	20.9
Smelt, A	2	20.8
Kingfish, A	1	20.8
Sea bass, A	1	20.7
Dab, E	1	20.6
Grouper, A	2	20.5
Yellow perch, A and E	3	20.4
Pike-perch, wall-eyed pike, A	1	20.3
Pickerel, A	2	20.3
Pike-perch, E	1	20.2
Conger eel, E	1	20.0
Containing between 20 and 15 per cent. of water-free substance.		
Pike, A and E	4	19.5
Pike-perch, gray pike, A	1	19.2
Crucian carp, E	1	19.2
Russian cod, E	1	18.7
Haddock, A and E	8	18.6
Tomcod, A	1	18.5
Red bass, A	1	18.4
Cusk, A	1	18.0
Cod, A and E	7	17.5
Whiting, E	1	17.0
Hake, A	1	16.9
Common flounder, A	2	15.8
Winter flounder, A	1	15.7
Containing between 15 and 10 per cent. of water-free substance.		
Sole, E	1	13.9
Barbel, E	1	10.7

Classification of American and European fish by proportions of fat in flesh of specimens analyzed.

[A, American; E, European.]

Kinds of fish.	No. of specimens analyzed.	Water.	Fats.
Containing over 5 per cent. of fats.			
Eel, A and E	4	64.5	18.7
California salmon, A	2	63.6	17.9
Turbot, A	1	71.4	14.4
Lamprey eel, A	1	71.1	13.3
Salmon, A and E	8	65.8	12.1
Lake trout, A	2	69.1	11.4
Butter-fish, A	1	70.0	11.1
Shad, A	7	70.6	9.5
Spanish mackerel, A	1	68.1	9.4
Mackerel, A and E	8	71.6	8.2
Bleak, E	1	72.9	8.2
Herring, A and E	4	72.1	8.0
Pompano, A	2	72.8	7.6
Whitefish, A	1	69.9	6.5
Sterlet, E	1	76.8	5.6
Halibut, A	3	75.4	5.2
Conger eel, E	1	79.9	5.1
Sturgeon, A	1	76.0	5.1
Porgy, A	3	74.9	5.1
Containing between 5 and 2 per cent. of fats.			
Alewife, A	2	74.5	4.9
Mullet, A	1	74.9	4.6
White perch, A	2	75.7	4.1
Sheepshead, A	2	75.6	3.7
Cisco, A	1	76.1	3.5
Smelt, E	1	78.4	3.1
Striped bass, A	6	77.8	2.9
Gudgeon, E	1	76.9	2.7
Muskellunge, A	1	76.2	2.5
Dab, E	1	79.4	2.5
Small-mouthed black bass, A	1	74.8	2.5
Salmon trout, E	1	75.3	2.5
Small-mouthed red-horse, A	1	78.6	2.4
Weakfish, A	1	78.9	2.4
Brook trout, A	3	77.7	2.1

Kinds of fish.	No. of specimens analyzed.	Water.	Fats.
Containing less than 2 per cent. of fats.			
Sturgeon, A	1	78.7	1.9
Plaice, E	1	77.4	1.8
Smelt, A	2	79.2	1.8
Whitefish, E	1	79.1	1.5
Blackfish, A	4	79.1	1.4
Carp, E	2	78.4	1.3
Bluefish, A	1	78.5	1.3
Red snapper, A	3	78.5	1.0
Large-mouthed black bass, A	1	78.6	1.0
Skate, A and E	2	78.8	1.0
Kingfish, A	1	79.2	1.0
Pike perch, Gray pike, A	1	80.9	0.8
Pollock, A	1	76.0	0.8
Yellow perch, A and E	3	79.5	0.7
Hake, A	1	83.1	0.7
Common flounder, A	2	84.2	0.7
Grouper, A	2	79.5	0.6
Russian cod, E	1	81.4	0.6
Red bass, A	1	81.6	0.6
Sea bass, A	1	79.3	0.5
Pickerel, A	2	79.7	0.5
Crucian carp, E	1	80.8	0.5
Pike perch, wall-eyed pike, A	1	79.7	0.5
Winter flounder, A	1	84.4	0.5
Whiting, E	1	82.9	0.4
Pike, A and E	4	80.5	0.4
Tomcod, A	1	81.6	0.4
Haddock, A and E	8	81.4	0.3
Cod, A and E	7	82.5	0.3
Barbel, E	1	89.4	0.2
Pike perch, E	1	79.9	0.2
Cusk, A	1	82.0	0.2
Sole, E	1	86.1	0.2

SECTION D.—MOLLUSKS, CRUSTACEANS, ETC.

1. LIST OF AMERICAN SPECIES ANALYZED.

	No. of specimens.
Mollusks:	
Oysters, *Ostrea virginica*	41
Scallops, *Pecten irradians*	2
Long clams, *Mya arenaria*	4
Round clams, or quahogs, *Venus mercenaria*	2
Mussels, *Mytilus edulis*	1
	50
Crustaceans.	
Lobsters, *Homarus americanus*	6
Crayfish, *Cambarus*, sp	1
Crabs, *Callinectes hastatus*	2
Shrimp	1
	10
Vertebrates:	
Terrapin, *Ptychemys?*	1
Green turtle, *Chelonia mydas*	1
	2

There were in all 62 specimens of 11 species of mollusks, crustaceans, and vertebrates.

2. METHODS OF ANALYSIS AND ANALYTICAL DETAILS.

METHODS OF ANALYSIS.

The methods of analysis employed were practically those used in the analysis of fish, and described in a previous part of this report. A few notes on special details of methods used for the invertebrates, especially the mollusks, will be in place here.

Many of the specimens examined, as oysters, clams, etc., are liable to have foreign matters, mud, sea-weed, hydroids, gastropods, etc., adhering to their shells. These foreign materials were removed by washing, after which the specimens were drained and wiped dry.

After the cleaning of their shells, the weighed oysters were opened, the liquid thus escaping being caught in a large evaporating dish. They were then put upon a porcelain colander ("crystal drainer") and the liquid contents allowed to drain into a beaker. In this way some very small particles of solid matter would probably be added to the filtrate. For the purpose of analysis the part remaining upon the dish was called "flesh," while that passing through was designated as "liquids." The flesh and liquids in canned oysters and those that were opened before they were received were separated in the same way. After this separation the flesh was chopped in a wooden tray until the sample was quite fine, and evenly and thoroughly mixed, as was done with the samples of fish above reported.

The specimens of clams and mussels were prepared in the same way as oysters. In the case of scallops only the part usually eaten, the muscle that holds the shell together (adductor muscle), was analyzed. This was analyzed as received, the flesh being chopped and sampled in the same way as that of the oyster.

In the case of lobsters, crabs, crayfish, and turtles the flesh was carefully separated from the shell and prepared as above. For the parts taken for analysis, see description of samples in the analytical details which follow.

In all of the samples a portion, usually about 100 grammes, of the chopped flesh was dried in hydrogen and prepared for analysis in the same manner as the hydrogen-dried samples of fish already described. The liquids were evaporated over a water bath, and then dried in air. After drying they were ground, sampled, and used for the determinations made in "liquids," the methods for which were in the main like that for the flesh.

DESCRIPTIONS OF SPECIMENS AND ANALYTICAL DETAILS.

The details of the analysis which follow contain the description of the samples and the details of the determinations. They are arranged in the order previously named, the specimens of each species being in the order of the laboratory numbers.

The description of the specimens of oysters and clams do not say, except in a very few cases, whether they were or were not "floated," *i. e.*, placed for a time in brackish or fresh water after removal from the beds. As the practice of floating is so universal, and as the specimens were received in the condition in which they are usually sold, it is probable that the majority, if not all, of the specimens, with the exception of those in cases specially referred to, had been floated.

The following data have been compiled from our laboratory notebooks, as was done with the analyses of fishes:

DESCRIPTIVE LIST OF THE MOLLUSKS, CRUSTACEA, ETC., ANALYZED.

54. Oysters. Fair Haven, Connecticut. Long Island Sound. Purchased in Middletown. The sample consisted of 33 oysters, one-half peck.

55. Oysters. Stony Creek, Connecticut. "Natives." Purchased in Middletown. Dredged April 4, 1881. Thirty-nine oysters, one peck. Length, from 4 to 6 inches; mostly 4½ to 5½ inches.

56. Oysters. "Blue Points." Patchogue, Long Island. Furnished by Mr. Blackford. Length, 2½ to 4¼ inches; breadth, 1½ to 2½ inches.

57. Oysters. "East Rivers." Cow Bay, Long Island Sound, New York. Furnished by Mr. Blackford. Length, 2½ to 5½ inches; breadth, 1⅝ to 3½ inches.

58. Oysters. "Rockaways." Presumably from Rockaway, Long Island. Furnished by Mr. Blackford. Length, 3¼ to 4½ inches; breadth, 2 to 3¼ inches.

59. Oysters. "Virginias." Presumably from Virginia. Furnished by Mr. Blackford. Length, 2¼ to 4½ inches; breadth, 1⅝ to 3½ inches.

60. Oysters. "Sounds." Staten Island, New York. Furnished by Mr. Blackford.

61. Oysters. "Shrewsbury." Presumably from Shrewsbury, New Jersey. Furnished by Mr. Blackford. The specimen consisted of 28 oysters in the shell.

68. Oysters. Buzzard's Bay, Massachusetts. Furnished by Mr. Blackford. The specimen consisted of 29 oysters in the shell.

70. Oysters. Providence River, Rhode Island. Purchased in Newton, Massachusetts. The specimen consisted of 28 oysters in the shell.

71. Oysters. James River, Virginia. Furnished by Mr. F. T. Lane, New Haven. Transplanted to New Haven, Connecticut. The specimen consisted of 30 oysters in the shell. An accompanying letter says: "From James River, Va., * * * are what we consider the best stock to plant; * * * have been planted here five weeks." Though not distinctly stated, the probable inference seems to be that the oysters were floated, like No. 72. Specimens taken from the same bed were analyzed five and one-half months later, October 31, as Nos. 82 and 83.

72. Oysters. Rappahannock River, Virginia. Furnished by Mr. Lane, New Haven. In an accompanying letter Mr. Lane says: "* * * From Rappahannock River; * * * are what we use mostly for winter and spring; * * * have been planted here three weeks, then taken up into a river where the water is quite fresh and put into floats for forty-eight hours to fatten them."

73. Oysters. Potomac River, Virginia. Furnished by Mr. Lane, New Haven. Transplanted to New Haven, Connecticut. The specimen consisted of 55 oysters in

the shell. In an accompanying letter Mr. Lane says: "These are from the Potomac River and the cheapest of anything we get from the South; * * * have been transplanted three weeks." Though not distinctly stated, the probable inference seems to be that the oysters are "floated," like No. 72. Specimens taken nearly six months later from the same bed were analyzed as Nos. 84 and 85.

74. Canned oysters, sometimes called "Cove Oysters." Chesapeake Bay. Furnished by Mr. J. F. Ely, Baltimore, Maryland. The samples consisted of a one-half pound can containing 30 oysters and a one-pound can containing 77 oysters. In an accompanying letter Mr. Ely states: "The oysters we 'steamers' use are gathered from all points in the Chesapeake Bay and mouth of the Potomac River. There is no agency but heat applied in the preparation."

75. Oysters. Stony Creek, Connecticut. Purchased in Middletown. The specimen consisted of 30 oysters in the shell.

82. Oysters. James River, Virginia. Furnished by Mr. F. T. Lane, New Haven. Transplanted to New Haven, Connecticut, April, 1881. Thirty-one oysters in the shell. Mr. Lane says: "These samples, 82 and 83, are from the James River, Virginia, planted here last April. No. 1 (this sample) is as they came from the bed. This is some of the same James River stock I sent you last spring." (No. 71.)

83. Oysters. James River, transplanted as 82. Furnished by Mr. F. T. Lane, New Haven. Thirty-four oysters in the shell. Mr. Lane says: "No. 2 (this sample) has been in the float 48 hours." Both 82 and 83 were taken from the same bed at the same time.

84. Oysters. Potomac River, transplanted to New Haven, Connecticut. Furnished by Mr. F. T. Lane, New Haven. Forty-one oysters in shell. Mr. Lane says: "Stock planted here last April. This sample has been in the float 48 hours. This is some of the same stock I sent you last spring." (No. 73.)

85. Oysters. Potomac River, Virginia. Furnished by Mr. F. T. Lane, New Haven. Transplanted as 84. Mr. Lane says: "This sample came direct from the beds." Both 84 and 85 were taken from the same bed at the same time. Thirty-five oysters in the shell.

89. Oysters. Fair Haven, Connecticut. New Haven Bay. Natives. Purchased in Middletown. The specimen consisted of one pint of the so-called "solids," *i. e.*, the shell contents as ordinarily sold, and contained the "flesh" or "meats" with part of the "liquids" or "liquor" of 36 oysters. The laboratory record contains the following entry: "The specimen, one pint, did not furnish enough liquids for analysis."

92. Oysters. Long Island Sound. Furnished by Mr. F. T. Lane, New Haven. Thirty-four oysters in shell. In accompanying letter Mr. Lane describes them as "outside" or "Sound" oysters, which we understand to mean that they were taken in Long Island Sound, outside of New Haven Harbor.

93. Oysters. Fair Haven, Connecticut. New Haven Bay. Furnished by Mr. F. T. Lane, New Haven. Thirty-six oysters in the shell. In accompanying letter Mr. Lane describes them as "inside" or "harbor" natives, which we understand to mean that they grew in New Haven Bay near Fair Haven.

97. Canned oysters. Purchased in Middletown. One "one-pound" can containing 78 oysters.

103. Oysters. Clinton, Connecticut. Long Island Sound. Natives. Purchased in Middletown. Thirty-one oysters in the shell, one-half peck. Price, 50 cents per peck.

104. Oysters. "Solids." Virginias transplanted to New Haven, Connecticut. Purchased in Middletown. Price 50 cents per quart. One quart of oysters, shell contents, as commonly sold. They were said to have come from Mr. F. T. Lane, of New Haven, and were very likely from the same beds as some of the specimens previously reported as received directly from Mr. Lane.

105. Oysters. Stony Creek, Connecticut. Long Island Sound. Purchased in Middletown. Thirty oysters in the shell, one peck. Price, 50 cents per peck.

106. Oysters. North Shrewsbury River, Shrewsbury, New Jersey. Furnished by Dorlon & Shaffer, New York. Twenty-five oysters in the shell.

107. Oysters. "Blue Points." Great South Bay, Long Island. Furnished by Dorlon & Shaffer, New York. Thirty oysters in shell.

108. Oysters. "East Rivers." Oyster Bay, Long Island. Furnished by Dorlon & Shaffer, New York. Twenty-five oysters in the shell.

109. Oysters. "Sounds." Princess Bay, Staten Island, New York. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

112. Oysters. "Rockaways." Far Rockaway, Long Island. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

118. Oysters. Norwalk, Connecticut. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

120. Canned oysters. Furnished by Thurber & Co., New York. One "one pound" can containing fifty oysters.

151. Oysters. Norwalk, Connecticut. Long Island Sound. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

180. Oysters. Oyster Bay, New York. Furnished by Dorlon & Shaffer, New York. Thirty-two oysters in the shell.

181. Oysters. Shrewsbury, New Jersey. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

182. Oysters. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell. The so-called "Blue Points," a favorite kind of oyster stated to come from sundry places on the coast of Long Island.

202. Oysters. "Solids." Virginia. Purchased in Middletown. The specimen consisted of one quart of the shell contents as ordinarily sold, containing 118 oysters and weighing 970.5 grammes. The dealer from whom they were purchased stated that they were received from F. T. Lane, of New Haven, where they "were taken from a vessel just in from Virginia." The amount of liquid was so small that no attempt was made to separate it from the flesh.

203. Oysters. Stony Creek, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one peck of oysters in the shell, containing 90 oysters, weighing 6,585 grammes. Price, 50 cents per peck. Said to be from the Stony Creek Oyster Company, Connecticut, and called "Offshore oysters."

204. Oysters. "Solids." Fair Haven, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one pint of the shell contents, the portion ordinarily sold, and contained 61 oysters, weighing 522.5 grammes. Price, 35 cents per quart. The amount of liquid was so small that no attempt was made to separate it from the flesh.

210. Oysters. Fair Haven, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one-half peck of Fair Haven natives in the shell and contained 20 oysters weighing 3,371 grammes. Price, 50 cents per peck.

51 and 63. Scallops. Furnished by Mr. Blackford. The specimens consisted of the adductor muscle only, the portion commonly eaten, and were in the form usually found for sale in the market.

65. "Long" Clams. Napaug, Long Island. Purchased in Middletown. The specimen consisted of 20 clams in the shell.

67. "Long" Clams. Boston Harbor, Massachusetts. Purchased in Newton, Massachusetts. The specimen consisted of 20 clams in the shell.

102. "Long" Clams. Clinton, Connecticut. Long Island Sound. Purchased in Middletown. Twenty-five clams in the shell. Price, 50 cents per peck.

122. Canned clams. "Long Clams." Penobscot Bay, Maine. Furnished by Thurber & Company, New York. One "one pound" can. The can bore the brand "Penobscot Bay, Little Neck Clams, Castine Packing Company, Maine."

201. Long Clams. Clinton, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one peck, containing 145 clams. Price per peck, 45 cents. Forty-five clams were taken for analysis.

66. "Round" Clams. Little Neck, New York. Purchased in Middletown. The specimen consisted of 20 clams in the shell.

139. Mussels. Stony Creek, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one peck containing 208 mussels in the shell. Price, 30 cents per peck. Fifty mussels were taken for analysis.

50. Lobster. Furnished by Mr. Blackford. Two lobsters entire and evidently lately caught.

Weighings in preparation for analysis.

Parts.	*a.*	*b.*	Average.
	Grms.	*Grms.*	*Grms.*
Edible portion:			
Body	118.5	127.5	123.0
Claws	152.5	219.5	186.0
Tail	138.0	131.0	134.5
Liquid portion	54.4	94.8	74.6
Total	463.4	572.8	518.1
Refuse	367.8	499.5	433.7
Loss	38.8	30.7	34.7
Total weight	870.0	1,103.0	986.5

62. Lobster. Furnished by Mr. Blackford. Locality unknown.

69. Lobster. Purchased in Newton, Massachusetts.

239. Lobster. Maine. Furnished by Mr. Blackford.

64. Crayfish, *Cambarus*. Species not determined. Furnished by Mr. Blackford. The specimen consisted of 21 crayfish, weighing 684.6 grammes, of which the abdomens ("tails") weighed 176.6 grams.

Weighings in preparation for analysis.

		Grms.
Cephalothorax		508.0
Abdomen:		
Edible portion, flesh	85.5	176.6
Refuse	83.8	
Loss	7.3	
Total		684.6

101. Crabs. ("Hard Crabs.") Coast of New Jersey. Furnished by Mr. Blackford. The specimen consisted of three entire crabs. They were boiled before the flesh was separated from the shells.

Weighings in preparation for analysis.

Parts.	*a.*	*b.*	*c.*	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*
Flesh	103.0	77.0	105.0	95.0
Refuse	120.5	103.5	114.5	112.8
Loss	11.5	5.7	4.7	7.3
Total	235.0	186.2	224.2	215.1

125. Canned round clams. Furnished by Thurber & Co., New York. One "one-pound" can, containing 25 clams. The can was labeled "Little Neck Clams."

76. Canned lobster. Purchased in Middletown. The contents weighed 469.5 grammes.

121. Canned lobster. Furnished by Thurber & Co., New York. One "one-pound" can, labeled "Thurber's Egmont Bay Fresh Lobster."

124. Canned crab. Hampton, Virginia. Furnished by Thurber & Co., New York. One "one-pound" can, labeled "Bryce's Fresh Crab Meat." It contained no seasoning except a little salt. The contents of the can weighed 607 grammes.

274. Canned crab. Hampton, Va. Furnished by Thurber & Co., New York. One "one-pound" can, bearing label "Bryce's Fresh Crab Meat." The can contents weighed 600 grammes.

123. Canned shrimps. Furnished by Thurber & Co., New York. Gulf of Mexico. One "half-pound" can, labeled "Barataria Shrimp."

235. Terrapin. Savannah, Georgia. Furnished by Mr. Blackford, the specimen consisting of two whole terrapin. The species was not determined.

Weighings in preparation for analysis.

Parts.	a.	b.	Average.
Flesh:	*Grms.*	*Grms.*	*Grms.*
Edible portion	183.0	45.0	114.0
Refuse	562.0	258.0	410.0
Loss	28.0	11.0	19.5
Total	773.0	314.0	543.5

272. Green turtle. Key West, Florida. Furnished by Mr. Blackford. One whole turtle. The larger portion of the muscle was taken for analysis.

DETAILS OF ANALYSES OF FLESH (AND "LIQUIDS") OF MOLLUSKS, CRUSTACEANS, ETC.

The following figures are transcribed from our laboratory books. Full details of analyses are given of a few specimens, showing what determinations were made, how they were recorded, and the calculations made from them. Following these statements are tabulated summaries of the determinations of all the specimens. The details of determinations of proximate ingredients are, however, omitted from the tabular statement, as in the details of analyses of the flesh of fishes, and for the same reason:

LABORATORY NUMBER 57.

Name: Oysters ("East Rivers").
Locality: Cow Bay, Long Island Sound, New York.
Received: April 8, 1881, from E. G. Blackford.
Description: Length, 2¼ to 5½ inches; breadth, 1¾ to 3½ inches.

Weighings in preparation for analysis.

	Grms.	*Lb.*	*Oz.*	*P. ct.*
Flesh	558.0	= 1	3.6	10.27
Liquid	543.7	1	3.1	10.01
Refuse (shells, etc.)	4284.7	9	7.2	78.86
Loss	47.3	....	1.7	.86
Total, 51 oysters	5433.7	11	15.6	100.00

Analysis of flesh.

Water (dried in hydrogen).	Partial drying.—100.00 grm. fresh substance, "Fr." = 21.30 grm. partially dried, "Pd." = 21.30% Pd. in Fr.	
	Complete drying.—1.0815 grm. Pd. = 1.0190 grm. Water-free "Wfr." = 94.22% Wfr. in Pd.	Av'ge 94.25% Wfr. in Pd.
	Complete drying.—1.1015 grm. Pd. = 1.0385 grm. Water-free "Wfr." = 94.28% Wfr. in Pd.	
	21.30% Pd. in Fr. × 94.25% Wfr. in Pd. = 20.08% Wfr. in Fr., or 79.92% Water in Fr.	
Nitrogen.	.601 grm. Pd. = .5664 grm. Wfr., gave .4717 grm. N. = 8.33% N.	Av'ge 8.32% N. in Wfr., or 1.67% N. in Fr.
	.600 = .5655 .4699 = 8.31	

Ether Ext. { 1.0815 grm. Pd. = 1.0190 grm. Wfr., gave .1095 grm. Ext. = 10.75% Ext. } Av'ge 10.79% Ext. in Wfr., or 2.16% Ext. in Fr.
{ 1.1015 = 1.0385 .1150 = 10.82

Ash. 2.276 grm. Pd. = 2.145 grm. Wfr., gave .1865 grm. Ash. = 8.69% Ash. in Wfr., or 1.74% Ash. in Fr.

P_2O_5 0.9030 grm. Pd. = 0 8511 grm. Wfr., gave 0.0138 grm. P_2O_5 = 1.62% P_2O_5 } Av'ge 1.62% P_2O_5 in Wfr., or 0.32% P_2O_5 in Fr.
0.9055 = 0.8535 0.0138 = 1.61

SO_3 0.9050 grm. Pd. = 0.8530 grm. Wfr., gave 0.0431 grm. SO_3 = 5.06% SO_3 } Av'ge 5.01% SO_3 in Wfr., or 1.00% SO_3 in Fr.
0.9020 = 0.8501 0.0422 = 4.96

Albumen in cold-water ext. { 33.3 grm. Fr. = 6.6933 grm. Wfr., gave 0.2455 grm. Alb. = 0.74% Alb. } Av'ge 0.75% Alb. in Fr., or 3.73% Alb. in Wfr.
{ 33.3 = 6.6933 0.2490 = 0.75

Analysis of liquids.

Water (dried in air). {
Partial drying.—543.7 grm. fresh substance, "Fr." = 24.8 grm. partially dried, "Pd." = 4.56% Pd. in Fr.
Complete drying.—1.000 grm. Pd. = 1.000 grm. Water-free, "Wfr." = 100.00% Wfr. in Pd. } Av'ge 100.00% Wfr. in Pd.
Complete drying.—1.000 grm. Pd. = 1.000 grm. Water-free, "Wfr." = 100.00% Wfr. in Pd.
4.56% Pd. in Fr. × 100.00% Wfr. in Pd. = 4 56% Wfr. in Fr., or 95.44% Water in Fr.

Nitrogen. { .6000 grm. Pd. = .6000 grm. Wfr., gave 0.03492 grm. N. = 5.82% N. } Av'ge 5.85% N. in Wfr. or 0.26% N. in Fr.
{ .6015 = .6015 0.03529 = 5.88

Ether ext. { 1.1385 grm. Pd. = 1.1385 grm. Wfr., gave .005 grm. Ext. = 0.44% Ext. } Av'ge 0.45% Ext. in Wfr., or 0 02% Ext. in Fr.
{ 1.1115 = 1.1115 .005 = 0.45

Ash. 3.000 grm. Pd. = 3.0000 grm. Wfr., gave 1.0335 grm. Ash. = 34.45% Ash. in Wfr., or 1.57% Ash in Fr.

Recapitulation of analysis.

[Protein = N × 6.25.]

Constituents.	In water-free substance.			In fresh substance.		
	Flesh.	Liquid.	Flesh + liquid.	Flesh.	Liquid.	Flesh + liquid.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Water	......	......	......	79.92	95.44	87.57
Protein	52.00	36.57	49.20	10.44	1.67	6.11
Fat (ether extract)	10.79	0.45	8.92	2.16	0.02	1.11
Carbohydrates, etc., (by difference)	28.52	28.53	28.52	5.74	1.30	3.55
Ash	8.69	34.45	13.36	1.74	1.57	1.66
	100.00	100.00	100.00	100.00	100.00	100.00

Proximate ingredients of flesh directly determined.

Constituents.	In water-free substance.	In fresh substance.
	P. ct.	*P. ct.*
Water	......	79.92
Albumen, coagulated from cold-water extract	3.73	0.75
Extractives, etc., not coagulated in cold-water ext.	26.88	5.40
Gelatin in hot-water extract	18.67	3.75
Insoluble protein	33.15	6.65
Ether extract	10.79	2.16
Ash	8.69	1.74
Total	101.91	100.37

LABORATORY NUMBER 109.

Name: Oysters, "Sounds."
Locality: Princess Bay, Staten Island, New York.
Received: November 30, 1881, from Dorlon & Shaffer, New York City.
Description: Thirty oysters in shell.

Weighings in preparation for analysis.

	Grms.	*Lbs.*	*Oz.*	*P. ct.*
Flesh	384.0	....	13.5	8.24
Liquid	436.0	....	15.4	9.35
Refuse	3,816.0	8	6.6	81.87
Loss	25.0	....	0.9	0.54
Total, 30 oysters	4,661.0	10	4.4	100.00

Analysis of flesh.

Water (dried in hydrogen).
- Partial drying.—100.10 grm. fresh substance, "Fr." = 17.54 grm. partially dried, "Pd." = 17.52% Pd. in Fr.
- Complete drying.—1,000 grm. Pd. = 0.9830 grm. Water-free, "Wfr." = 98.30% Wfr. in Pd.
- Complete drying.—1,000 grm. Pd. = 0.9823 grm. Water-free, "Wfr," = 98.23% Wfr. in Pd.
- Av'ge 98.27% Wfr. in Pd.
- 17.52% Pd. in Fr. × 98.27% Wfr. in Pd. = 17.21% Wfr. in Fr., or 82.79% Water in Fr.

Water (dried in air).
- Partial drying.—100.19 grm. fresh substance, "Fr." =17.28 grm. partially dried, "Pd." = 17.24% Pd. in Fr.
- Complete drying.—1,000 grm. Pd. = 0.9815 grm. Water-free, "Wfr." = 98.15% Wfr. in Pd.
- Complete drying.—1,000 grm. Pd. = 0.9817 grm. Water-free, "Wfr." = 98.17 Wfr. in Pd.
- Av'ge 98.16% Wfr. in Pd.
- 17.24% Pd. in Fr. × 98.16% Wfr. in Pd. = 16.96% Wfr. in Fr., or 83.04% Water in Fr.

Nitrogen. 0.500 grm. Pd. = 0.4914 grm. Wfr., gave 0.38344 grm. N. = 7.80% N.; 0.500 = 0.4914, 0.38534 = 7.84. Av'ge 7.82% N. in Wfr. or 1.35% N. in Fr.

Ether Ext. 1.500 grm. Pd. = 0.9827 grm. Wfr., gave 0.09975 grm. Ext. = 10.15% Ext.; 1.000 = 0.9827, 0.09950 = 10.12%. Av'ge 10.14% Ext. in Wfr. or 1.74% Ext. in Fr.

Ash. 3.000 grm. Pd. = 2.9481 grm. Wfr., gave 0.2940 grm. Ash. = 9.99% Ash.; 3.000 = 2.9481, 0.2925 = 9.92. Av'ge 9.96% Ash. in Wfr. or 1.71% Ash. in Fr.

LABORATORY NUMBER 102.

Name: "Long clams."
Locality: Clinton, Connecticut, Long Island Sound.
Purchased November 26, 1881, in Middletown.
Description: Twenty-five clams, in shell. Price 50 cts. per peck.

Weighings in preparation for analysis.

	Grms.	*Lb.*	*Oz.*	*P. ct.*
Flesh	485.5 =	1	1.2	32.89
Liquid	369.5 =	..	13.0	25.03
Refuse	601.0 =	1	5.2	40.72
Loss	20.0 =	..	0.7	1.36
Total, 25 clams	1,476.0	3	4.1	100.00

Analysis of flesh.

Water (dried in hydrogen).
- Partial drying.—100.50 grm. fresh substance, "Fr." = 22.60 grm. partially dried, "Pd." = 22.49% Pd. in Fr.
- Complete drying.—1.000 grm. Pd. = 0.9530 grm. Water-free, "Wfr." = 95.30% Wfr. in Pd.
- Complete drying.—1.000 grm. Pd. = 0.9527 grm. Water-free, "Wfr." = 95.27% Wfr. in Pd.
- Av'ge 95.27% Wfr. in Pd.
- 22.49% Pd. in Fr. × 95.29% Wfr. in Pd. = 21.43% Wfr. in Fr., or 78.57% Water in Fr.

Water (dried in air).
- Partial drying.—99.93 grm. fresh substance, "Fr." = 21.95 grm. partially dried, "Pd." = 21.97% Pd. in Fr.
- Complete drying.—1.000 grm. Pd. = 0.974 grm. Water-free, "Wfr." = 97.40% Wfr. in Pd.
- Complete drying.—1.000 grm. Pd. = 0.974 grm. Waterfree, "Wfr." = 97.40% Wfr. in Pd.
- Av'ge 97.40% Wfr. in Pd.
- 21.97% Pd. in Fr. + 97.40% Wfr. in Pd. = 21.39% Wfr. in Fr., or 78.61% Water in Fr.

Nitrogen. 0.500 grm. Pd. = 0.4765 grm. Wfr., gave 0.052815 grm. N. = 11.08% N.; 0.500 = 0.4765, 0.052983 = 11.12. Av'ge 11.10% N. in Wfr., or 2.38% N. in Fr.

Ether Ext. 1.000 grm. Pd. = 1.9529 grm. Wfr., gave 0.0790 grm. Ext. = 8.29% Ext.; 1.000 = 0,9529, 0.0795 = 8.34. Av'ge 8.32% Ext. in Wfr., or 1.78% Ext. in Fr.

Ash. 2.000 grm. Pd. = 1.9058 grm. Wfr., gave 0.2185 grm. Ash = 11.47% Ash; 2.000 = 1.9058, 0.2252 = 11.80. Av'ge 11.64% Ash in Wfr., or 2.49% Ash. in Fr.

Analysis of liquids.

Water (dried in air).
- Partial drying.—369.5 grm. fresh substance, "Fr." = 14.85 grm. partially dried, "Pd. = 4.02% Pd. in Fr.
- Complete drying.—1.000 grm. Pd. = 0.991 grm. Water-free, "Wfr." = 99.10% Wfr. in Pd.
- Complete drying.—1.000 grm. Pd. = 0.990 grm. Water-free, "Wfr." = 99.00% Wfr. in Pd.
- Av'ge 99.05% Wfr. in Pd.
- 4.02% Pd. in Fr. × 99.10% Wfr. in Pd. = 3.98% Wfr. in Fr., or 96.02% Water in Fr.

Nitrogen. 0.500 grm. Pd. = 0.4953 grm. Wfr., gave 0.013065 grm. N. = 2.64% N.; 0.500 = 0.4953, 0.012875 = 2.60. Av'ge 2.62% N. in Wfr., or 0.11% N. in Fr.

Ether Ext.	1.000 grm. Pd. = 0.9905 grm. Wfr., gave 0.001 grm. Ext. = 0.10% Ext.				Av'ge 0.10% Ext. in Wfr., or 0.00% Ext. in Fr.
	1.000	= 0.9905	0,001	= 0.10	
Ash.	2.000 grm. Pd. = 1.981 grm. Wfr., gave 1.3950 grm. Ash. = 70.38% Ash.				Av'ge 70.41% Ash. in Wfr., or 2.81% Ash. in Fr.
	2.000	= 1.981	1.4115	= 71.21	
	2.000	= 1.981	1.380	= 69.63	

Recapitulation of analysis.

[Protein = N × 6.25.]

Constituents.	In water-free substance.			In fresh substance.		
	Flesh.	Liquid.	Flesh + liquid.	Flesh.	Liquid.	Flesh + liquid.
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Water	....	....	....	78.57	96.02	86.11
Protein	69.37	16.37	62.81	14.86	0.65	8.71
Fat (ether ext.)	8.32	0.10	7.30	1.78	0.00	1.01
Carbohydrates, etc. (by difference)	10.67	13.12	10.97	2.30	0.52	1.54
Ash	11.64	70.41	18.92	2.49	2.81	2.63
	100.00	100.00	100.00	100.00	100.00	100.00

LABORATORY NUMBER 50.

Name: Lobster.

Received: March 15, 1881, from E. G. Blackford, fish commissioner of the State of New York.

Description: Two lobsters, entire, and evidently lately caught.

Weighings in preparation for analysis.

Parts.	a.	b.	Average.	Average.		Per cent.
Edible portions:	Grms.	Grms.	Grms.	Lbs.	Oz.	
Body	118.5	127.5	123.0	....	4.3	12.46
Claws	152.5	219.5	186.0	....	6.5	18.86
Tail	138.0	131.0	134.5	....	4.8	13.64
Liquid	54.4	94.8	74.6	....	2.6	7.56
Total edible	463.4	572.8	518.1	1	2.2	52.52
Refuse	367.8	499.5	433.7	....	15.3	43.96
Loss	38.8	30.7	34.7	....	1.3	3.52
Total weight	870.0	1,103.0	986.5	2	2.8	100.00

Analysis of flesh (edible portion).

Water, (dried in hydrogen).
Partial drying.—113.0 grm. fresh substance, "Fr." = 18.3 grm. partially dried, "Pd.," = 16.19 % Pd. in Fr.
Complete drying.—1.6815 grm. Pd. = 1.6305 grm. Water free, "Wfr." = 96.97 % Wfr. in Pd.
Complete drying.—1.6220 grm. Pd. = 1.5725 grm. Water free, "Wfr." = 96.95 % Wfr. in Pd.
Av'ge 96.96 % Wfr. in Pd.
16.19 % Pd. in Fr. × 96.96 % Wfr. in Pd. = 15.70 % Wfr. in Fr., or 84.30 % Water in Fr.

Nitrogen.	0.5995 grm. Pd. = 0.5812 grm. Wfr., gave 0.06890 grm. N. = 11.85 % N.				Av'ge 11.85 % N. in Wfr. or 1.86 % N. in Fr.
	0.6015	= 0.5832	0.06909	11.85	
Ether Ext.	0.6257 grm. Pd. = 0.6067 grm. Wfr., gave 0.0708 grm. Ext. = 11.67 % Ext.				Av'ge 11.62 % Ext. in Wfr. or 1.82 % Ext. in Fr.
	0.6345	0.6154	0.0715	= 11.55	
Ash.	2.0535 grm. Pd. = 1.927 grm. Wfr., gave 0.200 grm. Ash = 10.38 % Ash.				Av'ge 10.38 % Ash in Wfr. or 1.63 % Ash in Fr.
P_2O_5	0.9115 grm. Pd. = 0.8553 grm. Wfr., gave 0.0182 grm. P_2O_5 = 2.13 % P_2O_5				Av'ge 2.13 % P_2O_5 in Wfr. or 0.33 % P_2O_5 in Fr.
	0.9130	0.8567	0.0182	2.13	
SO_3.	0.9050 grm. Pd. 0.8510 grm. Wfr., gave 0.0203 grm. SO_3 2.39 % SO_3				Av'ge 2.39 % SO_3 in Wfr. or 0.38 % SO_3 in Fr.
	0.9065	0.8525	0.0203	2.38	
Albumen in cold-water Ext.	33.3 grm. Fr. 5.2333 grm. Wfr., gave 0.1775 grm. Alb. = 0.53 % Alb.				Av'ge 0.58 % Alb. in Fr. or 3.69 % Alb. in Wfr.
	33.3	= 5.2333	0.2065	0.62	

Extractives, etc., in cold-water Ext.

33.3 grm. Fr. = 5.2333 grm. Wfr., gave 1.9795 grm. crude Ext. = 5.94 % crude Ext.
33.3 grm. Fr. = 5.2333 grm. Wfr., gave 1.9320 grm. crude Ext. = 5.80 % crude Ext.
Av'ge 5.87 % crude Ext. in Fr. or 37.38 % crude Ext. in Wfr.

0.6545 grm. crude Ext. gave	0.0270 grm.	water	= 4.12 %	water	
0.6545	0.0150	fat	= 2.39	fat	26.23 % = 73.77 % pure Ext. in crude Ext.
1.1430	0.2160	ash	= 19.72	ash	

37.38 % crude Ext. = 27.58 % pure Ext. in Wfr. = 4.33 % pure Ext. in Fr.

Gelatin in hot-water Ext.

33.3 grm. Fr. = 5.2333 grm. Wfr., gave 0.9600 grm. crude gel. = 2.88 % crude gel.
33.3 grm. Fr. = 5.2333 grm. Wfr., gave 0.9400 grm. crude gel. = 2.82 % crude gel.
Av'ge 2.85 % crude gel. in Fr. or 18.15 % crude gel. in Wfr.

0.5360 grm. crude gel. gave	0.0115 grm.	water	= 2.15 %	water	
0.5360	0.0035	fat	= 0.67	fat	9.97 % = 90.03 % pure gel. in crude gel.
0.9600	0.0670	ash	= 7.15	ash	

18.15 % crude gel. = 16.34 % pure gel. in Wfr. = 2.57 % pure gel. in Fr.

Insoluble protein.

33.3 grm. Fr. = 5.2333 grm. Wfr., gave 1.531 grm. crude Ins. = 4.59 % crude Ins.
33.3 grm. Fr. = 5.2333 grm. Wfr., gave 1.652 grm. crude Ins. = 4.95 % crude Ins.
Av'ge 4.77 % crude Ins. in Fr. or 30.38 % crude Ins. in Wfr.

0.8515 grm. crude Ins. gave	0.0245 grm.	water	= 2.88 %	water	
0.8515	0.0050	fat	= 0.60	fat	5.72 % = 94.28 % pure Ins. in crude Ins.
1.8170	0.0395	ash	= 2.24	ash	

30.38 % crude Ins. = 28.64 % pure Ins. in Wfr. = 4.48 % pure Ins. in Fr.

Recapitulation of analysis of flesh.

Constituents.	Protein = N × 6.25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	....	84.30	....	84.30
Protein	74.06	11.63	78.00	12.25
Ether extract	11.62	1.82	11.62	1.82
Ash	10.38	1.63	10.38	1.63
Total	96.06	99.38	100.00	100.00

Proximate ingredients of flesh directly determined.

Constituents.	In water-free substance.	In fresh substance.	In fresh substance, calculated to 100 per cent.
Water	....	84.30	84.54
Albumen, coagulated in cold-water, ext	3.69	0.58	0.58
Extractives, etc., not coagulated in cold-water ext	27.58	4.33	4.34
Gelatin in hot-water extract	16.34	2.57	2.58
Insoluble protein	28.64	4.48	4.49
Ether extract	11.62	1.82	1.83
Ash	10.38	1.63	1.64
Total	98.25	99.71	100.00

Details of analyses of flesh (and liquids) of specimens of mollusks, crustaceans, etc.

[Determinations of water, nitrogen, ether extract (fat), and ash.]

Laboratory No. of specimen. F=flesh, L=liquid.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
F. 54	19.22	97.28 97.30	97.29	8.44 8.48	8.46	10.84 11.00	10.92	11.77	11.77
L. 54	6.11	98.15 98.09	98.12	5.54 5.58	5.56	0.26 0.28	0.27	53.13	53.13
F. 55	19.50	97.35 97.31	97.33	8.79 8.84	8.82	8.33 8.49	8.41	14.58	14.58
L. 55	6.51	59.61 59.51	59.56	3.42 3.41	3.42	0.35 0.34	0.35	70.91	70.91
F. 56	23.88	97.22 97.26	97.24	7.05 7.10	7.08	9.90 9.87	9.89	8.29	8.29
L. 56	5.67	100.00 100.00	100.00	6.49 6.51	6.50	1.57 1.50	1.54	33.74	33.74
F. 57	21.30	94.22 94.28	94.25	8.33 8.31	8.32	10.75 10.82	10.79	8.69	8.69
L. 57	4.56	100.00 100.00	100.00	5.82 5.88	5.85	0.44 0.45	0.45	34.45	34.45
F. 58	19.50	96.08 96.06	96.07	7.83 7.85	7.84	11.31 11.37	11.34	8.94	8.94
L. 58	4.97	99.38 99.41	99.39	5.34 5.30	5.32	0.71 0.70	0.71	45.75	45.75
F. 59	16.80	96.05 96.07	96.06	9.22 9.26	9.24	9.10 8.93	9.01	11.27	11.27
L. 59	3.19	99.12 99.15	99.14	5.23 5.21	5.22	0.19 0.16	0.18	52.03	52.03
F. 60	15.90	97.71 97.65	97.68	8.39 8.38	8.39	10.85 10.82	10.84	9.10	9.10
L. 60	3.69	98.99 98.87	98.93	5.69 5.73	5.71	2.52 2.58	2.55	23.15	23.15
F. 61	19.00	96.51 96.60	96.56	7.15 7.15	7.15	12.06 11.94	12.00	7.24	7.24
L. 61	4.96	99.51 99.61	99.56	6.60 6.60	6.60	0.88 0.88	0.88	37.18	37.18
F. 68	17.30	91.40 91.19	91.30	7.87 7.82	7.85	9.97 9.93	9.95	9.39	9.39
L. 68	3.62	99.52 99.52	99.52	5.54 5.61	5.58	0.07 0.07	0.07	45.27	45.27
F. 70	23.20	90.44 90.53	90.49	7.89 7.80	7.85	12.12 12.37	12.25	10.15	10.15
L. 70	4.95	99.86 99.86	99.86	4.79 4.76	4.78	0.04 0.04	0.04	48.79	48.79
F. 71	17.70	93.30 93.29	93.30	8.02 8.00	8.01	10.86 10.66	10.76	10.48	10.48
L. 71	4.13	98.84 99.07	98.96	4.63 4.65	4.64	0.24 0.29	0.27	62.37	62.37
F. 72	18.40	94.44 94.31	94.37	7.86 7.83	7.85	10.92 10.99	10.96	9.12	9.12
L. 72	2.78	99.14 99.21	99.18	5.89 5.89	5.89	0.24 0.24	0.24	49.87	49.87
F. 73	22.70	93.09 93.08	93.09	7.43 7.42	7.43	10.69 10.85	10.77	12.02	12.02
L. 73	4.52	99.54 99.37	99.45	5.17 5.14	5.16	0.25 0.25	0.25	54.96	54.96
F. 74	22.80	94.15 94.12	94.14	10.50 10.50	10.50	17.82 17.69	17.76	7.51	7.51
L. 74	6.87	93.66 93.64	93.65	4.41 4.40	4.41	4.14 4.14	4.14	18.88	18.88
F. 75	19.40	92.26 92.33	92.30	8.82 8.83	8.83	8.21 8.37	8.29	14.30	14.30
L. 75	3.71	98.95 98.92	98.94	2.77 2.88	2.83	1.31 1.30	1.31	70.46	70.46
F. 82	24.00	93.40 93.45	93.43	7.71 7.73	7.72	11.87 11.76	11.82	10.00 10.02	10.01
L. 82	5.51	95.40 95.49	95.45	5.96 5.91	5.94	0.80 0.74	0.77	48.40	48.40
F. 83	17.80	96.35 96.35	96.35	8.17 8.15	8.16	11.05 11.10	11.08	8.94 9.00	8.97
L. 83	4.98	96.10 96.10	96.10	6.99 7.03	7.01	2.81 2.81	2.81	29.60 29.61	29.61
F. 84	19.25	91.20 91.10	91.15	8.13 8.09	8.11	10.83 10.75	10.79	8.78 8.77	8.78

Details of analyses of flesh (and liquids) of specimens of mollusks, etc.—Continued.

Laboratory No. of specimen. F = flesh, L = liquid.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
L. 84	4.36	98.80 98.78	98.79	7.66 7.74	7.70	0.30 0.27	0.29	27.83 27.62	27.71
F. 85	22.55	96.15 96.20	96.18	7.49 7.43	7.46	10.55 10.55	10.55	9.78 9.87	9.83
L. 85	5.11	98.00 98.05	98.03	5.81 5.76	5.79	0.35 0.30	0.33	49.30	49.30
F. 89	16.80	95.45 95.40	95.43	7.15 7.13	7.14	12.26 12.31	12.29	5.32 5.36	5.34
L. 89	3.93	96.88 96.92	96.90	6.89 6.85	6.87	0.50 0.48	0.49	14.55 14.50	14.53
F. 92	22.00	97.70 97.70	97.70	8.62 8.66	8.64	8.62 8.55	8.59	11.68 11.80	11.74
L. 92	6.45	95.90 95.95	95.93	5.92 5.94	5.93	0.26 0.26	0.26	51.41 50.82	51.12
F. 93	25.50	92.40 92.40	92.40	7.37 7.39	7.38	10.39 10.34	10.37	8.42 8.47	8.45
L. 93	5.72	97.38 97.40	97.39	6.14 6.14	6.14	0.31 0.31	0.31	44.10 43.34	43.73
F. 97	28.20	83.50 83.60	83.55	9.12 9.16	9.14	18.68 18.73	18.71	7.03 6.97	7.00
L. 97	6.90	96.15 96.23	96.19	3.48 3.46	3.47	1.51 1.56	1.54	14.16 14.11	14.14
F. 103	19.69	96.95 97.00	96.98	8.11 8.09	8.10	9.72 9.79	9.76	12.04 11.91	11.98
L. 103	4.07	97.80 97.85	97.83	4.44 4.44	4.44	0.41 0.36	0.39	55.97 54.90	55.44
F. 104	14.87	97.50 97.55	97.53	8.31 8.27	8.29	12.61 12.56	12.59	7.79 7.67	7.73
L. 104	3.58	99.75 99.72	99.74	6.41 6.41	6.41	0.55 0.60	0.58	21.45 21.36	21.41
F. 105	22.87	96.95 97.00	96.98	7.67 7.63	7.65	10.39 10.46	10.43	11.31 11.29	11.30
L. 105	4.65	99.05 99.00	99.03	4.75 4.70	4.73	0.20 0.20	0.20	50.54 50.59	50.57
F. 106	23.51	95.40 95.38	95.39	6.94 6.88	6.91	11.85 11.90	11.88	8.30 8.35	8.33
L. 106	4.82	96.50 96.47	96.49	6.49 6.46	6.48	0.90 0.85	0.88	42.13 42.03	42.08
F. 107	25.17	97.08 97.15	97.12	8.72 8.71	8.71	8.27 8.26	8.27	10.48 10.54	10.51
L. 107	3.25	95.72 95.66	95.69	3.86 3.84	3.85	0.25 0.23	0.24	61.60 61.62	61.61
F. 108	25.29	97.98 98.02	98.00	6.50 6.50	6.50	11.53 11.58	11.56	7.58 7.53	7.56
L. 108	5.33	96.14 96.18	96.16	5.67 5.61	5.64	1.85 1.82	1.84	45.44 45.37	45.41
F. 109	17.52	98.30 98.23	98.27	7.80 7.84	7.82	10.15 10.12	10.14	9.99 9.92	9.96
L. 109	3.53	95.22 95.25	95.24	5.19 5.23	5.21	0.26 0.26	0.26	55.70 55.65	55.68
F. 112	23.33	95.80 95.75	95.78	7.57 7.51	7.54	12.16 12.18	12.17	9.03 9.08	9.06
L. 112	5.33	97.65 97.76	97.68	5.44 5.40	5.42	0.26 0.24	0.25	49.13 49.14	49.14
F. 118	19.64	95.07 95.10	95.09	8.14 8.18	8.16	8.10 8.12	8.11	11.23 11.23	11.23
L. 118	3.60	98.50 98.57	98.54	3.61 3.52	3.57	0.32 0.30	0.31	65.48 65.41	65.45
F. 120	24.12	94.33 94.30	94.32	9.26 9.19	9.23	18.61 18.66	18.64	6.36 6.36	6.36
L. 120	9.62	98.00 98.10	98.05	3.38 3.31	3.35	1.33 1.30	1.32	11.63 11.63	11.63
F. 151	20.57	94.80 94.75	94.78	8.16 8.19	8.18	9.71 9.65	9.68	11.04 11.01	11.03
L. 151	3.74	98.48 98.50	98.49	3.30 3.31	3.31	0.40 0.43	0.42	67.82 67.75	67.79
F. 180	23.99	92.15 92.10	92.13	7.68 7.68	7.68	10.64 10.64	10.64	9.88 9.92	9.90
L. 180	4.73	99.11 99.07	99.09	4.96 4.98	4.97	0.25 0.30	0.28	50.63 50.56	50.60
F. 181	19.60	93.25 93.20	93.23	8.02 8.02	8.02	10.89 10.99	10.94	9.18 9.25	9.22

Details of analyses of flesh (and liquids) of specimens of mollusks, etc.—Continued.

Laboratory No. of specimen. F = flesh, L = liquid.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
L. 181	3.54	98.28 98.23	98.26	6.31 6.33	6.32	0.36 0.36	0.36	48.95 48.85	48.90
F. 182	17.55	91.35 91.35	91.35	8.78 8.78	8.78	10.13 10.09	10.11	9.90 9.98	9.94
L. 182	3.17	98.93 98.95	98.94	4.67 4.69	4.68	0.36 0.36	0.36	53.71 53.79	53.75
F. 202	12.63	95.82 95.75	95.78	8.08 8.09	8.09	12.92 13.00	12.96	6.34 6.39	6.37
F. 203	20.07	97.57 97.59	97.58	8.46 8.49	8.48	9.43 9.43	9.43	11.32 11.32	11.32
L. 203	4.83	97.40 97.39	97.40	4.82 4.83	4.83	0.62 0.62	0.62	53.31 53.13	53.22
F. 204	11.88	97.39 97.40	97.39	8.16 8.18	8.17	13.34 13.30	13.32	7.70 7.64	7.67
F. 210	19.65	97.70 97.69	97.70	8.25 8.23	8.24	10.62 10.68	10.66	9.60 9.62	9.61
L. 210	4.77	96.94 97.00	96.98	6.24 6.22	6.23	0.62 0.68	0.65	45.11 45.37	45.24
51	24.01	92.54 92.45	92.50	10.85 10.83	10.84	0.13 0.13	0.13	6.68	6.68
63	18.98	90.32 90.52	90.42	13.46 13.46	13.46	1.76 1.76	1.76	7.51	7.51
F. 65	19.80	95.70 95.76	95.73	10.58 10.55	10.57	8.08 7.98	8.03	8.23	8.23
L. 65	5.25	99.53 99.48	99.51	3.91 3.92	3.92	0.57 0.52	0.55	56.00	56.00
F. 67	23.99	91.88 91.93	91.89	10.56 10.55	10.56	8.10 8.16	8.13	12.51	12.51
L. 67	4.27	99.81 99.81	99.81	1.85 1.86	1.86	0.14 0.14	0.14	77.20	77.20
F. 102	22.49	95.30 95.27	95.29	11.08 11.12	11.10	8.29 8.34	8.32	11.47 11.80	11.64
L. 102	4.02	99.10 99.00	99.05	2.64 2.60	2.62	0.10 0.10	0.10	70.38 71.21 69.63	70.41
F. 122	28.79	88.10 88.05	88.08	11.28 11.17 11.18	11.21	11.39 11.42	11.41	12.43 12.46	12.45
L. 122	8.29	97.42 97.43	97.43	4.95 4.91	4.93	0.46 0.39	0.43	21.29 21.25	21.27
F. 201	20.45	98.06 98.07	98.07	10.07 10.06	10.07	8.41 8.46	8.44	15.56 15.48	15.52
L. 201	3.23	100.00 100.00	100.00	3.28 3.29	3.29	0.40 0.40	0.40	63.50 63.32	63.41
F. 66	23.20	93.86 93.75	93.81	8.52 8.52	8.52	3.44 3.34	3.39	10.19	10.19
L. 66	4.89	99.66 99.66	99.66	2.93 2.99	2.96	0.34 0.34	0.34	64.97	64.97
F. 139	22.16	96.35 96.35	96.35	9.39 9.36	9.38	7.84 7.85	7.85	8.12 8.09	8.11
L. 139	5.91	97.70 97.69	97.70	4.88 4.85	4.87	2.22 2.26	2.24	38.56 38.66	38.61
50	16.19	96.97 96.95	96.96	11.85 11.85	11.85	11.67 11.55	11.62	10.38	10.38
62	19.12	95.34 95.32	95.33	12.33 12.33	12.33	8.43 8.50	8.47	9.36	9.36
69	19.56	91.46 91.46	91.46	13.44 13.43	13.44	14.20 14.17	14.19	10.43	10.43
239	22.27	93.52 93.57	93.55	13.23 13.24	13.24	6.95 6.93	6.94	7.80 7.78	7.79
64	19.81	94.83 94.79	94.81	13.61 13.64	13.63	2.45 2.45	2.45	6.98	6.98
101	23.40	98.00 98.00	98.00	11.63 11.59	11.61	8.57 8.53	8.55	13.61 13.67	13.64
F. 125	27.16	90.00 89.95	89.98	10.93 10.92	10.93	5.17 5.22	5.20	9.56 9.50	9.53
L. 125	10.00	94.73 94.80	94.77	6.87 6.88	6.88	2.71 2.74	2.73	34.42 34.45	34.43
76	23.10	89.39 89.34	89.37	12.99 12.97	[illegible]	2.33 2.14	2.24	13.44	13.44
121	25.88	92.20 92.17	92.19	13.09 13.10 13.09	13.09	7.05 7.05	7.05	9.03 9.00	9.01

Details of analyses of flesh (and liquids) of specimens of mollusks, etc.—Continued.

Laboratory No. of specimen. F = flesh, L = liquid.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
124	20.94	90.85 90.80	90.83	13.15 13.12	13.14	4.19 4.13	4.16	9.36 9.39	9.38
274	22.93	91.85 91.87	91.86	12.18 12.16	12.17	10.91 10.97	10.94	9.96 10.00	9.98
123	32.09	91.00 91.00	91.00	13.89 13.91	13.90	3.46 3.41	3.44	8.82 8.85	8.84
235	26.34	96.90 96.89	96.90	13.28 13.31	13.30	13.56 13.61	13.59	4.01 3.97	3.99
272	21.20	95.33 95.39	95.36	15.69 15.70	15.70	2.68 2.60	2.64	6.00 5.92	5.96

Details of analyses of flesh of specimens of mollusks, crustaceans, etc.

[Determinations of phosphorus and sulphur.]

Laboratory number of specimen.	Phosphorus as P_2O_5.			Sulphur as SO_3.		
	Individual determinations.		Average.	Individual determinations.		Average.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
54	1.57	1.57	1.57	5.51	5.67	5.59
55	1.46	1.46	1.46	5.36	5.26	5.31
56	1.29	1.26	1.28	3.64	3.77	3.70
57	1.62	1.61	1.62	5.06	4.96	5.01
58	1.59	1.58	1.59	3.91	3.87	3.89
59	1.78	1.80	1.79	2.89	2.87	2.88
60	1.99	1.96	1.98	3.19	3.19	3.19
61	1.61	1.61	1.61	2.25	2.21	2.23
68	1.47	1.48	1.48	4.14	4.16	4.15
70	1.64	1.64	1.64	3.55	3.54	3.55
71	1.82	1.75	1.79	2.76	2.80	2.78
72	1.83	1.76	1.80	2.12	2.14	2.13
73	1.82	1.67	1.75	2.59	2.59	2.59
74	1.61	1.62	1.62	0.95	0.93	0.94
75	1.76	1.77	1.77	3.65	3.64	3.65
51	2.14	2.19	2.17	2.25	2.20	2.23
63	2.75	2.75	2.75	2.76	2.75	2.76
65	2.48	2.48	2.48	2.32	2.37	2.35
67	2.23	2.20	2.21	3.14	3.14	3.14
66	1.77	1.96	1.86	4.09	4.13	4.11
50	2.13	2.13	2.13	2.39	2.38	2.39
62	2.23	2.24	2.24	1.97	1.96	1.97
69	2.39	2.31	2.35	3.12	2.99	3.06
64	2.85	2.84	2.85	1.38	1.40	1.39
76	1.14	1.11	1.13	2.34	2.34	2.34

3. ANALYSES OF AMERICAN MOLLUSKS, CRUSTACEANS, ETC.

DESCRIPTION OF THE TABLES.

Table 33 contains a list of the specimens analyzed. The specimens of oysters, and of other species as well, are arranged in order of the locality from which the specimens were obtained, the more northern coming first. In the second column is given the date of receipt of the samples at the laboratory. In most cases they had been taken from the water two or three days before being received by us. As will be seen in the third column, the number taken for analysis was generally large in order to obtain a fair sample. In the fourth column are given the total weights of the samples taken for analysis, and in the fifth the average weights of the individual specimens. Details as to the proportions of shell, flesh, liquids, total edible portion, etc., in the several samples of oysters and other invertebrates, are given under the heading "Constituents in whole specimen." The figures for "flesh" denote the percentage of solids or "meat;" those under liquids, the liquid portion, "liquor" in the sample. The solids and liquids together are designated "total edible portion," which with refuse and loss in preparation make up the whole sample.

Under the heading "In flesh" are given the percentages of water and dry substance in the flesh. After these follow the same percentages for liquids and for the total edible portion.

Table 34 gives the proximate percentage composition calculated on water free (dry) substance. The percentages of albuminoids were obtained by multiplying the percentages of nitrogen by the factor 6.25.

Table 35 contains the results of the analyses calculated to the water content of the fresh substance. The term, "fresh substance," as here used, refers to the flesh and liquids as they were obtained by the separations described under methods of analysis of invertebrates, etc. The percentages in the column headed "Extractives" are obtained by difference. That is, the albuminoids (as computed by multiplying nitrogen by 6.25), fats, and ash, are added and their sum subtracted from the total dry substance. Though this method of computation is common in the statements of the composition of animal and vegetable materials, it is, of course, only an approximately accurate way of getting over the difficulty of determining and stating the amounts of the several ingredients. It will be noticed that "extractives" as thus determined by difference are not the same as the "extractive matters" of the tables of the fish analyses.

Table 36 gives the percentages of phosphorus, calculated as phosphoric anhydride, and of sulphur calculated as sulphuric anhydride. The percentages are given calculated to dry substance and to fresh substance.

TABLE 33.—*Mollusks, crustaceans, etc.; list of specimens, names, localities, and proportions of flesh, etc.*

Name and locality of specimen.	Lab. No. of specimen.	Specimens received.	Number taken for analysis.	Total weight.	Average weight.	Constituents in whole specimen.					In flesh.		In liquids.		In total edible portion (flesh plus liquids).		In whole specimen.		
						Flesh.	Liquids.	Total edible portion.	Refuse (shells, etc.).	Loss in preparation for analysis.	Water.	Water-free substance.	Water.	Water-free substance.	Water.	Water-free substance.	Water-free substance of flesh.	Water-free substance of liquids.	Water-free substance of edible portion.
				Grms.	*Grms.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Oysters (Ostrea virginica) in shell:																			
Buzzard's Bay, Mass	68	May, 1881	29	2764.0	95.3	12.50	7.51	20.01	79.77	0.22	84.21	15.79	96.40	3.60	88.80	11.20	1.98	0.27	2.25
Providence River, R. I	70	...do	28	3301.0	117.9	10.88	6.12	17.00	82.41	0.59	79.01	20.99	95.05	4.95	84.79	15.21	2.28	0.30	2.58
Clinton, Conn	103	Nov., 1881	31	2573.0	83.0	11.67	13.20	24.87	74.02	1.11	80.91	19.09	96.02	3.98	88.84	11.16	2.23	0.53	2.76
Stony Creek, Conn	55	Apr., 1881	39	6685.0	171.4	7.52	11.38	18.90	79.74	1.36	81.02	18.98	96.12	3.88	90.11	9.89	1.43	0.44	1.87
Do	75	May, 1881	30	3448.0	114.9	7.34	11.81	19.15	79.66	1.19	82.09	17.91	96.33	3.67	90.92	9.08	1.31	0.43	1.74
Do	105	Nov., 1881	30	3253.0	108.4	10.96	7.27	18.23	80.69	1.08	77.82	22.18	95.40	4.60	84.83	15.17	2.43	0.33	2.76
Do	203	Mar., 1882	30	2579.0	86.0	11.17	9.33	20.50	77.82	1.68	80.42	19.58	95.30	4.70	87.19	12.81	2.19	0.44	2.63
Do. (average of 4 specimens)					120.0	9.25	9.95	19.20	79.48	1.32	80.34	19.66	95.79	4.21	88.26	11.74	1.84	0.41	2.24
Fair Haven, Conn	54	Apr., 1881	33	3784.5	114.7	12.63	5.43	18.06	79.92	2.02	81.30	18.70	94.00	6.00	85.12	14.88	2.36	0.33	2.69
Do	93	Nov., 1881	36	2981.0	82.8	12.26	12.05	24.31	74.87	0.82	76.44	23.56	94.43	5.57	85.25	14.75	2.89	0.67	3.56
Do	210	Mar., 1882	20	3371.0	168.5	12.19	4.40	16.59	82.55	0.86	80.80	19.20	95.38	4.62	84.67	15.33	2.34	0.21	2.55
Do. (average of 3 specimens)					122.0	12.36	7.29	19.65	79.12	1.23	79.51	20.49	94.60	5.40	85.00	15.00	2.53	0.40	2.93
Long Island Sound (near New Haven), Conn	92	Nov., 1881	34	3514.0	103.4	9.72	4.90	14.62	84.09	1.29	78.51	21.49	93.81	6.19	83.64	16.36	2.09	0.30	2.39
Norwalk, Conn	118	Dec., 1881	30	6347.0	211.6	7.61	10.24	17.85	81.16	0.99	81.33	18.67	96.46	3.54	90.01	9.99	1.42	0.36	1.78
Do	151	Feb., 1882	30	7547.0	251.6	7.27	9.78	17.05	81.92	1.03	80.50	19.50	96.32	3.68	89.58	10.42	1.42	0.36	1.78
Do. (average of 2 specimens)					231.6	7.44	10.01	17.45	81.54	1.01	80.92	19.08	96.39	3.61	89.80	10.20	1.42	0.36	1.78
Oyster Bay, Long Island Sound, N. Y	108	Nov., 1881	25	4156.0	166.3	11.91	8.40	20.31	78.84	0.85	75.22	24.78	94.87	5.13	83.35	16.65	2.95	0.43	3.38
Do	180	Feb., 1882	32	5228.0	163.4	10.85	6.42	17.27	81.67	1.06	77.90	22.10	95.31	4.69	84.37	15.63	2.39	0.31	2.70
Do. (average of 2 specimens)					164.9	11.38	7.41	18.79	75.26	0.96	76.56	23.44	95.09	4.91	83.86	16.14	2.67	0.37	3.04
Cow Bay, East River, N. Y	57	Apr., 1881	51	5433.7	106.5	10.27	10.01	20.28	78.86	0.86	79.92	20.08	95.44	4.56	87.57	12.43	2.07	0.46	2.53
Rockaway, N. Y	58	..do	50	5058.0	101.2	10.68	7.72	18.40	81.18	0.42	81.27	18.73	95.06	4.94	87.06	12.94	2.00	0.38	2.38
Do	112	Nov., 1881	30	4187.0	139.5	12.11	7.73	19.84	78.53	1.63	77.66	22.34	94.79	5.21	84.33	15.67	2.71	0.40	3.11
Do. (average of 2 specimens)					120.4	11.40	7.72	19.12	79.85	1.03	79.46	20.54	94.92	5.08	85.70	14.30	2.36	0.39	2.75
"Blue Points," Patchogue, Long Island, N. Y	56	Apr., 1881	47	3725.5	79.3	13.39	5.23	18.62	80.16	1.22	76.77	23.23	94.33	5.67	81.70	18.30	3.11	0.30	3.41
"Blue Points," Great South Bay, Long Island, N. Y	107	Nov., 1881	30	3537.0	117.9	6.50	9.67	16.17	83.36	0.47	75.55	24.45	96.89	3.11	88.30	11.70	1.59	0.30	1.89
"Blue Points," (Long Island coast, N. Y. ?)	182	Feb., 1882	30	5818.0	193.9	8.01	7.41	15.42	84.10	0.48	83.97	16.03	96.87	3.13	90.17	9.83	1.29	0.23	1.52
Do. (average of 3 specimens)					130.4	9.30	7.44	16.74	82.54	0.72	78.76	21.24	96.03	3.97	86.72	13.28	2.00	0.28	2.28

Staten Island, N. Y	60	Apr., 1881	30	3901.5	130.5	9.13	7.10	16.23	83.16	0.61	84.47	15.53	96.35	3.65	89.67	10.33	1.42	0.26	1.68
Princess Bay, Staten Island, N. Y.	109	..do	30	4661.0	155.3	8.24	9.35	17.59	81.87	0.54	82.79	17.21	96.64	3.36	90.15	9.85	1.42	0.31	1.73
Do. (average of 2 specimens)					142.9	8.69	8.23	16.91	82.52	0.58	83.63	16.37	96.50	3.50	89.91	10.09	1.42	0.29	1.71
Shrewsbury, N. J	61	Apr., 1881	28	3904.0	139.4	12.64	4.88	17.52	81.76	0.72	81.65	18.35	95.07	4.93	85.39	14.61	2.31	0.24	2.55
Do	106	Nov., 1881	25	3954.0	158.1	11.27	8.40	19.67	79.69	0.64	77.58	22.42	95.35	4.65	85.17	14.83	2.53	0.39	2.92
Do	181	Feb., 1882	30	5184.0	172.8	9.55	9.68	19.23	79.82	0.95	81.73	18.27	96.52	3.48	89.16	10.84	1.75	0.34	2.09
Do. (average of 3 specimens)					156.8	11.15	7.66	18.81	80.42	0.77	80.32	19.68	95.65	4.35	86.57	13.43	2.20	0.32	2.52
Norfolk, Va	59	Apr., 1881	48	6635.5	138.3	4.66	6.52	11.18	88.31	0.51	83.86	16.14	96.83	3.17	91.42	8.58	0.75	0.21	0.96
Potomac River, Va.:																			
Transplanted*‡	73	May, 1881	55	3501.4	63.7	6.51	5.64	12.15	87.10	0.75	78.87	21.13	95.51	4.49	86.60	13.40	1.38	0.25	1.63
Transplanted) ‡ § ¶	84	Nov., 1881	41	4081.0	99.5	10.18	6.48	16.66	82.97	0.37	82.06	17.94	95.69	4.31	87.36	12.64	1.83	0.28	2.11
Transplanted) * § **	85	..do	35	3624.0	103.5	8.35	7.78	16.13	83.25	0.62	77.90	22.10	94.99	5.01	86.14	13.86	1.85	0.39	2.24
Do. (average of 3 specimens)					88.9	8.35	6.63	14.98	84.44	0.58	79.61	20.39	95.40	4.60	86.70	13.30	1.69	0.30	1.99
Rappahannock River, Va. (transplanted) * ‡ ¶	72	May, 1881	28	3309.5	118.2	7.86	7.31	15.17	84.02	0.81	82.64	17.36	97.24	2.76	89.68	10.32	1.36	0.20	1.56
James River, Va.:																			
Transplanted* ‖	71	..do	30	3085.0	102.8	6.50	7.29	13.79	85.30	0.91	83.49	16.51	95.91	4.09	90.05	9.95	1.07	0.30	1.37
Transplanted * § **	82	Nov., 1881	31	3293.0	106.2	9.49	5.51	15.00	84.36	0.64	77.99	22.01	94.74	5.26	84.15	15.85	2.09	0.29	2.38
Transplanted * § ¶	83	..do	34	3614.0	106.3	11.41	5.76	17.17	82.35	0.48	82.77	17.23	95.22	4.78	86.95	13.05	1.96	0.28	2.24
Do. (average of 3 specimens)					105.1	9.13	6.19	15.32	84.00	0.68	81.42	18.58	95.29	4.71	87.05	12.95	1.71	0.29	2.00
Average of 34 specimens					128.6	9.80	7.87	17.67	81.45	0.88	80.31	19.69	95.61	4.39	87.13	12.87	1.92	0.34	2.26
Oysters, "Solids," out of shell †:																			
Fair Haven, Conn	89	Nov., 1881	36	1021.4	28.3	90.39	9.61	100.00			84.04	15.96	96.19	3.81	85.21	14.79	14.42	0.37	14.79
Do	204	Mar., 1882	61	522.5	8.6			100.00							88.44	11.56			11.56
Virginia (transplanted)*	104	Nov., 1881	90	828.4	9.2	84.20	15.80	100.00			85.50	14.50	96.43	3.57	87.23	12.77	12.21	0.56	12.77
Do*	202	Mar., 1882	118	970.5	8.2			100.00							87.90	12.10			12.10
Do. (average of 4 samples)								100.00							87.19	12.81			12.81
Oysters, "Cove," canned:																			
Chesapeake Bay	74	May, 1881	77	581.7	7.5	49.29	50.71	100.00			78.53	21.47	93.57	6.43	86.02	13.98	10.58	3.26	13.84
Do	97	Nov., 1881	78	604.1	7.8	49.41	50.59	100.00			76.75	23.25	93.35	6.65	85.15	14.85	11.49	3.36	14.85
Do	120	..do	50	621.0	12.4	44.60	55.40	100.00			77.25	22.75	90.57	9.43	84.60	15.40	10.17	5.23	15.40
Do. (average of 3 samples)					9.2	47.77	52.23	100.00			77.51	22.49	92.50	7.50	85.26	14.74	10.75	3.95	14.70
Scallops (Pecten irradians)††:																			
Shelter Island, New York	51	Mar., 1881				100.00		100.00			77.79	22.21			77.79	22.21	22.21		22.21
Do	63	Apr., 1881				100.00		100.00			82.84	17.16			82.84	17.16	17.16		17.16
Do. (average of 2 specimens)						100.00		100.00			80.32	19.68			80.32	19.68	19.68		19.68
Long clams (Mya arenaria) in shell:																			
Boston, Mass	67	May, 1881	20	1504.0	75.2	29.26	24.64	53.90	45.18	0.92	77.96	22.04	95.74	4.26	86.09	13.91	6.45	1.05	7.50
Clinton, Conn	102	Nov., 1881	25	1476.0	59.1	32.89	25.03	57.92	40.72	1.36	78.57	21.43	96.02	3.98	86.11	13.89	7.05	1.00	8.05
Do	201	Mar., 1882	45	2061.0	45.8	39.37	16.93	56.30	41.71	1.99	79.94	20.06	96.77	3.23	85.00	15.00	7.89	0.55	8.44
Do. (average of 2 specimens)					52.5	36.13	20.98	57.11	41.22	1.67	79.26	20.74	96.40	3.60	85.55	14.45	7.47	0.78	8.25
Long Island, N. Y	65	Apr., 1881	20	1378.5	68.9	36.49	21.15	57.64	39.93	2.43	81.05	18.95	94.76	5.24	86.10	13.90	6.91	1.11	8.02
Average of 4 specimens					62.3	34.50	21.94	56.44	41.88	1.68	79.38	20.62	95.82	4.18	85.82	14.18	7.07	0.93	8.00
Long clams, canned:																			
Penobscot Bay, Me	122	Nov., 1881	37	458.0	12.4	42.70	57.30	100.00			74.63	25.37	91.92	8.08	84.54	15.46	10.83	4.63	15.46
Round clams (V. mercenaria) in shell:																			
Little Neck, N.Y	66	Apr., 1881	20	1907.5	95.4	16.80	14.91	31.71	67.50	0.79	78.24	21.76	95.12	4.88	86.18	13.82	3.66	0.73	4.39
Round clams, canned:																			
Islip, Long Island, N. Y	125	Nov., 1881	25	409.5	16.4	50.55	49.45	100.00			75.56	24.44	90.52	9.48	82.96	17.04	12.35	4.69	17.04

* To New Haven, Conn. † Shell contents, including flesh and liquids. ‡ Taken from beds about 3 weeks after transplanting. § About 6 months after transplanting. ‖ About 5 weeks after transplanting. ¶ Floated. ** Not floated. †† The adductor muscle, the portion ordinarily eaten.

TABLE 33.—*Mollusks, crustaceans, etc.; list of specimens, names, localities, and proportions of flesh, etc.*—Continued.

Name and locality of specimen.	Lab. No. of specimen.	Specimens received.	Number taken for analysis.	Total weight.	Average weight.	Constituents in whole specimen.					In flesh.		In liquids.		In total edible portion. (flesh plus liquids).		In whole specimen.		
						Flesh.	Liquids.	Total edible portion.	Refuse, (shells, etc.).	Loss in preparation for analysis.	Water.	Water-free substance.	Water.	Water-free substance.	Water.	Water-free substance.	Water-free substance of flesh.	Water-free substance of liquids.	Water-free substance of edible portion.
Mussels (Mytilus edulis) in shell:				*Grms.*	*Grms.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Stony Creek, Conn	139	Dec., 1881	50	1378.0	27.6	32.66	18.00	50.66	46.69	2.65	78.67	21.33	94.23	5.77	84.20	15.80	6.97	1.04	8.01
Lobster (H. americanus) in shell:																			
Locality unknown (Maine or Massachusetts?)	50	Mar., 1881	2	1973.0	986.5	......	......	52.52	43.96	3.52	......	......	......	......	84.30	15.70	......	......	8.25
Do	62	Apr., 1881	1	876.5	876.5	......	......	36.24	60.87	2.89	......	......	......	......	81.77	18.23	......	......	6.60
Do	239	Apr., 1882	1	893.0	893.0	......	......	32.24	62.47	5.29	......	......	......	......	79.17	20.83	......	......	6.72
Do	69	May, 1881	1	1335.0	1335.0	......	......	30.56	67.57	1.87	......	......	......	......	82.11	17.89	......	......	5.47
Do. (average of 4 specimens)	....	......	...	......	1022.8	......	......	37.89	58.72	3.39	......	......	......	......	81.84	18.16	......	......	6.76
Lobster, canned:																			
Maine	76	May, 1881	...	469.5	......	......	......	100.00	......	......	......	......	......	......	79.36	20.64	......	......	20.64
Do	121	Nov., 1881	...	......	......	......	......	100.00	......	......	......	......	......	......	76.15	23.85	......	......	23.85
Do. (average of 2 samples)	....	......	...	......	......	......	......	100.00	......	......	......	......	......	......	77.75	22.25	......	......	22.25
Crayfish (Cambarus) in shell:																			
Potomac River, Va	64	Apr., 1881	21	695.0	33.1	......	......	12.30	85.15	2.55	......	......	......	......	81.22	18.78	......	......	2.31
Crab (Callinectes hastatus) in shell:																			
New Jersey	101	Nov., 1881	3	645.4	215.1	......	......	44.16	52.44	3.40	......	......	......	......	77.07	22.93	......	......	10.13
Crabs, canned:																			
Hampton, Va	124	...do	....	607.0	......	......	......	100.00	......	......	......	......	......	......	80.98	19.02	......	......	19.02
Do	274	Apr., 1882	..	600.0	......	......	......	100.00	......	......	......	......	......	......	78.95	21.05	......	......	21.05
Do. (average of 2 samples)	....	......	....	......	......	......	......	100.00	......	......	......	......	......	......	79.97	20.03	......	......	20.03
Shrimp, canned:																			
Gulf of Mexico	123	Nov., 1881	....	291.5	......	......	......	100.00	......	......	......	......	......	......	70.80	29.20	......	......	29.20
Terrapin, in shell:																			
Savannah, Ga	235	Apr., 1882	2	1087.0	543.5	......	......	20.97	75.44	3.59	......	......	......	......	74.47	25.53	......	......	5.35
Green turtle (Chelonia mydas) in shell:																			
Key West, Fla	272	May, 1882	1	5471.0	5471.0	......	......	24.03	75.97	......	......	......	......	......	79.78	20.22	......	......	4.86

TABLE 34.—*Analyses of mollusks, crustaceans, etc., calculated on water-free substance.*

Name and locality of specimen.	Lab. No. of specimen.	Specimen received.	Ingredients. In flesh. Nitrogen.	In flesh. Protein (nitrogen × 6.25).	In flesh. Fat (ether extract).	In flesh. Crude ash.	In liquids. Nitrogen.	In liquids. Protein (nitrogen × 6.25).	In liquids. Fat (ether extract).	In liquids. Crude ash.	In total edible portion (flesh plus liquids). Nitrogen.	In total edible portion. Protein (nitrogen × 6.25).	In total edible portion. Fat (ether extract).	In total edible portion. Crude ash.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Oysters (Ostrea virginica) in shell:														
Buzzard's Bay, Mass	68	May, 1881	7.85	49.06	9.95	9.39	5.58	34.87	0.07	45.27	7.58	47.36	8.75	13.71
Providence River, R. I	70	do	7.85	49.06	12.25	10.15	4.78	29.87	0.04	48.79	7.49	46.82	10.82	14.67
Clinton, Conn	103	Nov., 1881	8.10	50.62	9.76	11.98	4.44	27.75	0.39	55.44	7.41	46.32	7.99	20.17
Stony Creek, Conn	55	Apr., 1881	8.82	55.13	8.41	14.58	3.42	21.37	0.35	70.91	7.54	47.15	6.50	27.90
Do	75	May, 1881	8.83	55.19	8.29	14.30	2.83	17.69	1.31	70.46	7.37	46.06	6.59	27.98
Do	105	Nov., 1881	7.65	47.81	10.43	11.30	4.73	29.56	0.20	50.57	7.30	45.61	9.19	16.04
Do	203	Mar., 1882	8.48	53.00	9.43	11.32	4.83	30.19	0.62	53.22	7.87	49.19	7.96	18.31
Do. (average of 4 specimens)			8.45	52.78	9.14	12.88	3.95	24.70	0.62	61.29	7.52	47.00	7.56	22.56
Fair Haven, Conn	54	Apr., 1881	8.46	52.88	10.92	11.77	5.56	34.76	0.27	53.13	8.11	50.67	9.63	16.79
Do	93	Nov., 1881	7.38	46.13	10.37	8.45	6.14	38.38	0.31	43.73	7.15	44.68	8.49	15.05
Do	210	Mar., 1882	8.24	51.50	10.66	9.61	6.23	38.94	0.65	45.24	8.08	50.50	9.86	12.45
Do. (average of 3 specimens)			8.03	50.17	10.65	9.94	5.98	37.36	0.41	47.37	7.78	48.62	9.33	13.76
Long Island Sound (near New Haven, Conn.)	92	Nov., 1881	8.64	54.00	8.59	11.74	5.93	37.06	0.26	51.12	8.29	51.85	7.54	16.73
Norwalk, Conn	118	Dec., 1881	8.16	51.00	8.11	11.23	3.57	22.31	0.31	65.45	7.23	45.19	6.52	22.28
Do	151	Feb., 1882	8.18	51.13	9.68	11.03	3.31	20.69	0.42	67.79	7.19	44.97	7.80	22.53
Do. (average of 2 specimens)			8.17	51.07	8.90	11.13	3.44	21.50	0.37	66.62	7.21	45.08	7.16	22.40
Oyster Bay, Long Island Sound, N. Y	108	Nov., 1881	6.50	40.63	11.56	7.56	5.64	35.25	1.84	45.41	6.39	39.94	10.30	12.39
Do	180	Feb., 1882	7.68	48.01	10.64	9.90	4.97	31.06	0.28	50.60	7.38	46.13	9.48	14.44
Do. (average of 2 specimens)			7.14	48.32	11.10	8.73	5.32	33.16	1.06	48.01	6.89	43.04	9.89	13.42
Cow Bay, East River, N. Y	57	Apr., 1881	8.32	52.00	10.79	8.69	5.85	36.57	0.45	34.45	7.87	49.20	8.92	13.36
Rockaway, N. Y	58	do	7.84	49.00	11.34	8.94	5.32	33.27	0.71	45.75	7.44	46.48	9.64	14.84
Do	112	Nov., 1881	7.54	47.12	12.17	9.06	5.42	33.88	0.25	49.14	7.27	45.41	10.62	14.25
Do. (average of 2 specimens)			7.69	48.06	11.76	9.01	5.37	33.57	0.48	47.45	7.36	45.95	10.13	14.55
"Blue Points," Patchogue, Long Island, N. Y	56	Apr., 1881	7.08	44.25	9.89	8.29	6.50	40.62	1.54	33.74	7.03	43.97	9.16	10.51
"Blue Points," Great South Bay, Long Island, N. Y	107	Nov., 1881	8.71	54.44	8.27	10.51	3.85	24.06	0.24	61.61	7.94	49.60	6.99	18.65
"Blue Points," (Long Island Coast, N. Y.?)	182	Feb., 1882	8.78	54.87	10.11	9.94	4.68	29.25	0.36	53.75	8.15	50.94	8.62	1[illegible].65
Do. (average of 3 specimens)			8.19	51.19	9.42	9.58	5.01	31.31	0.71	49.70	7.71	48.17	8.26	15.27
Staten Island, N. Y	60	Apr., 1882	8.39	52.45	10.84	9.10	5.71	35.68	2.55	23.15	7.98	49.85	9.56	11.33
Princess Bay, Staten Island, N. Y	109	do	7.82	48.87	10.14	9.96	5.21	32.56	0.26	55.68	7.35	45.92	8.35	18.24
Do. (average of 2 specimens)			8.11	50.66	10.48	9.53	5.46	34.12	1.41	39.42	7.67	47.89	8.96	14.79
Shrewsbury, N. J	61	Apr., 1882	7.15	44.69	12.00	7.24	6.60	41.25	0.88	37.18	7.10	44.36	10.97	10.05
Do	106	Nov., 1882	6.91	43.19	11.88	8.33	6.48	40.50	0.88	42.08	6.85	42.83	10.40	12.85
Do	181	Feb., 1882	8.02	50.14	10.94	9.22	6.32	39.50	0.36	48.90	7.75	48.41	9.23	15.63
Do. (average of 3 specimens)			7.36	46.00	11.61	8.26	6.47	40.42	0.71	42.72	7.23	45.20	10.20	12.84

TABLE 34.—*Analyses of mollusks, crustaceans, etc., calculated on water-free substance*—Continued.

Name and locality of specimen.	Lab. No. of specimen.	Specimen received.	Ingredients. In flesh. Nitrogen.	In flesh. Protein (nitrogen×6.25).	In flesh. Fat (ether extract).	In flesh. Crude ash.	In liquids. Nitrogen.	In liquids. Protein (nitrogen×6.25).	In liquids. Fat (ether extract).	In liquids. Crude ash	In total edible portion (flesh plus liquids). Nitrogen.	Protein (nitrogen×6.25).	Fat (ether extract).	Crude ash.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Oysters (Ostrea virginica) in shell—Continued.														
Norfolk, Va	59	Apr., 1881	9.24	57.75	9.01	11.27	5.22	32.63	0.18	52.03	8.37	52.31	7.16	20.06
Potomac River, Va. (transplanted) * ‡	73	May, 1881	7.43	46.44	10.77	12.02	5.16	32.24	0.25	54.96	7.07	44.21	9.14	18.70
Do* § ¶	84	Nov., 1881	8.11	50.69	10.79	8.78	7.70	48.14	0.29	27.71	8.06	50.36	9.31	11.29
Do* § ¶	85	...do	7.46	46.63	10.55	9.83	5.79	36.19	0.33	49.30	7.17	44.81	8.76	16.71
Do. (average of 3 specimens)	....	....	7.67	47.92	10.70	10.21	6.22	38.86	0.29	43.99	7.43	46.46	9.07	15.57
Rappahannock River, Va. (transplanted) * ‡ ¶	72	May, 1881	7.85	49.06	10.96	9.12	5.89	36.81	0.24	49.87	7.60	47.48	9.58	14.38
James River, Va. (transplanted) * ∥	71	...do	8.01	50.06	10.76	10.48	4.64	29.00	0.27	62.37	7.28	45.48	8.48	21.76
Do * ‡ **	82	Nov., 1881	7.72	48.25	11.82	10.01	5.94	37.13	0.77	48.40	7.50	46.88	10.48	14.68
Do * ‡ **	83	...do	8.16	51.00	11.08	8.97	7.01	43.81	2.81	29.61	8.02	50.12	10.06	11.51
Do. (average of 3 specimens)	....	....	7.96	49.77	11.22	9.82	5.86	36.65	1.28	46.79	7.60	47.49	9.67	15.98
Average of 34 specimens of oysters in shell	....	....	7.98	49.88	10.39	10.12	5.33	33.32	0.62	49.32	7.53	47.09	8.78	16.38
Oysters, "Solids," out of shell: †														
Fair Haven, Conn	89	Nov., 1881	7.14	44.63	12.29	5.34	6.87	42.94	0.49	14.53	7.13	44.58	11.99	5.56
Do	204	Mar., 1882	......	......	......	......	......	......	......	......	8.17	51.06	13.32	7.67
Virginia (transplanted) *	104	Nov., 1881	8.29	51.81	12.59	7.73	6.41	40.06	0.58	21.41	8.21	51.31	12.06	8.32
Do	202	Mar., 1882	......	......	......	......	......	......	......	......	8.09	50.56	12.96	6.37
Do. (average of 4 samples)	....	....	......	......	......	......	......	......	......	......	7.90	49.38	12.58	6.98
Oysters, "Cove," canned:														
Chesapeake Bay	74	May, 1881	10.50	65.62	17.76	7.51	4.41	27.56	4.14	18.88	9.11	56.92	14.64	10.11
Do	97	Nov., 1881	9.14	57.13	18.71	7.00	3.47	21.69	1.54	14.14	7.86	49.10	14.82	8.61
Do	120	...do	9.23	57.69	18.64	6.36	3.35	20.93	1.32	11.63	7.24	45.23	12.77	8.15
Do. (average of 3 samples, canned oysters)	....	....	9.62	60.15	18.37	6.96	3.74	23.39	2.33	14.88	8.07	50.42	14.07	8.96
Scallops (Pecten irradians): ††														
Shelter Island, N. Y	51	Mar., 1881	10.84	67.75	0.13	6.68	......	......	......	......	10.84	67.75	0.13	6.68
Do	63	Apr., 1881	13.46	84.13	1.76	7.51	......	......	......	......	13.46	84.13	1.76	7.51
Do. (average of 2 specimens)	....	....	12.15	75.94	0.95	7.10	......	......	......	......	12.15	75.94	0.95	7.10
Long clams (Mya arenaria), in shell:														
Boston, Mass	67	May, 1881	10.56	66.00	8.13	12.51	1.86	11.62	0.14	77.20	9.34	58.39	7.01	21.57
Clinton, Conn	102	Nov., 1881	11.10	69.37	8.32	11.64	2.62	16.37	0.10	70.41	10.05	62.81	7.30	18.92
Do	201	Mar., 1882	10.07	62.92	8.44	15.52	3.29	20.56	0.40	63.41	9.63	60.19	7.92	18.62
Do. (average of 2 specimens), Clinton	....	....	10.59	66.14	8.38	13.58	2.95	18.47	0.25	66.91	9.84	61.50	7.61	18.77
Long Island, New York	65	Apr., 1881	10.57	66.06	8.03	8.23	3.92	24.50	0.55	56.00	9.65	60.32	7.00	14.82
Average of 4 specimens	....	....	10.58	66.09	8.23	11.98	2.92	18.26	0.30	66.76	9.67	60.29	7.31	18.48

Long clams, canned:														
Penobscot Bay, Maine	122	Nov., 1881	11.21	70.06	11.41	12.45	4.93	30.81	0.43	21.27	9.33	58.32	8.12	15.09
Round clams (Venus mercenaria), in shell:														
Little Neck, N. Y	66	Apr., 1881	8.52	53.25	3.39	10.19	2.96	18.50	0.34	64.97	7.60	47.49	2.88	19.28
Round clams, canned:														
Islip, Long Island, N. Y	125	Nov., 1881	10.93	68.31	5.20	9.53	6.88	43.00	2.73	34.43	9.81	61.32	4.52	16.38
Mussels (Mytilus edulis), in shell:														
Stony Creek, Conn	139	Dec., 1881	9.38	58.64	7.85	8.11	4.87	30.43	2.24	38.61	8.80	55.00	7.12	12.06
Lobster (Homarus americanus), in shell:														
Locality unknown (Maine or Massachusetts ?)	50	Mar., 1881	......	......	......	......	......	......	......	......	11.85	74.06	11.62	10.38
Do	62	Apr., 1881	......	......	......	......	......	......	......	......	12.33	77.06	8.47	9.36
Do	239	Apr., 1882	......	......	......	......	......	......	......	......	13.24	82.75	6.94	7.79
Do	69	May, 1881	......	......	......	......	......	......	......	......	13.44	84.00	14.19	10.43
Do. (average of 4 specimens)	.....	......	......	......	......	......	......	......	......	......	12.72	79.47	10.31	9.49
Lobster, canned:														
Maine	76	May, 1881	......	......	......	......	......	......	......	......	12.98	81.13	2.24	13.44
Do	121	Nov., 1881	......	......	......	......	......	......	......	......	13.09	81.81	7.05	9.01
Do (average of 2 samples)	.....	......	......	......	......	......	......	......	......	......	13.04	81.46	4.64	11.23
Crayfish (Cambarus), in shell:														
Potomac River, Virginia	64	Apr., 1881	......	......	......	......	......	......	......	......	13.63	85.19	2.45	6.98
Crab (Callinectes hastatus), in shell:														
New Jersey	101	Nov., 1881	......	......	......	......	......	......	......	......	11.61	72.56	8.55	13.64
Crabs, canned:														
Hampton, Va	124	....do	......	......	......	......	......	......	......	......	13.14	82.14	4.16	9.38
Do	274	Apr., 1882	......	......	......	......	......	......	......	......	12.17	76.06	10.94	9.98
Do. (average of 2 samples)	.....	......	......	......	......	......	......	......	......	......	12.65	79.10	7.55	9.68
Shrimp, canned:														
Gulf of Mexico	123	Nov., 1881	......	......	......	......	......	......	......	......	13.90	86.89	3.44	8.84
Terrapin, in shell:														
Savannah, Ga	235	Apr., 1882	......	......	......	......	......	......	......	......	13.30	83.13	13.59	3.99
Green turtle (Chelonia mydas), in shell:														
Key West, Fla	272	May, 1882	......	......	......	......	......	......	......	......	15.70	98.13	2.64	5.96

* To New Haven, Conn.
† i. e. shell contents, including flesh and liquids.
‡ Taken from beds about three weeks after transplanting.
§ About six months after transplanting.
‖ About five weeks after transplanting.
¶ Floated.
** Not floated.
†† The adductor muscle, the portion ordinarily eaten.

TABLE 35.—*Analyses of mollusks, crustaceans, etc., calculated on fresh substance.*

Name and locality of specimen.	Laboratory No. of specimen.	Specimen received.	Edible portion. In flesh. Water.	In flesh. Nitrogen.	In flesh. Protein (nitrogen × 6.25).	In flesh. Fat (ether extract).	In flesh. Crude ash.	In liquids. Water.	In liquids. Nitrogen.	In liquids. Protein (nitrogen × 6.25).	In liquids. Fat (ether extract).	In liquids. Crude ash.	In edible portion (flesh plus liquids). Water.	In edible portion. Water-free substance.	In edible portion. Protein (nitrogen × 6.25).	In edible portion. Fat (ether extract).	In edible portion. Crude ash.	In edible portion. Extractives.	In edible portion. Nitrogen.	In whole sample. Total edible portion. (From Table 33.)	In whole sample. Total water-free subst'ce, actual nutrients.
Oysters (Ostrea virginica), in shell:			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Buzzard's Bay, Mass	68	May, 1881	84.21	1.24	7.75	1.57	1.48	96.40	0.20	1.23	0.00	1.63	88.80	11.20	5.31	0.99	1.53	3.37	0.85	20.01	2.25
Providence River, R. I	70	...do	79.01	1.65	10.30	2.58	2.13	95.05	0.24	1.48	0.00	2.41	84.79	15.21	7.13	1.65	2.23	4.20	1.14	17.00	2.58
Clinton, Conn	103	Nov., 1881	80.91	1.55	9.67	1.86	2.29	96.02	0.18	1.10	0.02	2.21	88.84	11.16	5.17	0.89	2.25	2.85	0.83	24.87	2.76
Stony Creek, Conn	55	Apr., 1881	81.02	1.67	10.46	1.60	2.76	96.12	0.13	0.83	0.01	2.72	90.11	9.89	4.66	0.64	2.76	1.83	0.75	18.90	1.87
Do	75	May, 1881	82.09	1.58	9.88	1.48	2.55	96.33	0.10	0.65	0.05	2.61	90.92	9.08	4.18	0.60	2.54	1.76	0.67	19.15	1.74
Do	105	Nov., 1881	77.82	1.70	10.60	2.32	2.51	95.40	0.22	1.36	0.01	2.33	84.83	15.17	6.94	1.39	2.42	4.42	1.11	18.23	2.76
Do	203	Mar., 1882	80.42	1.66	10.38	1.85	2.22	95.30	0.23	1.42	0.03	2.50	87.19	12.81	6.30	1.03	2.34	3.14	1.01	20.50	2.63
Do. (average of 4 specimens)			80.31	1.65	10.33	1.81	2.51	95.79	0.17	1.06	0.02	2.54	88.26	11.74	5.52	0.92	2.52	2.79	0.89	19.20	2.24
Fair Haven, Conn	54	Apr., 1881	81.30	1.58	9.89	2.05	2.20	94.00	0.33	2.08	0.02	3.19	85.12	14.88	7.54	1.43	2.50	3.41	1.21	18.06	2.69
Do	93	Nov., 1881	76.24	1.75	10.96	2.47	2.01	94.43	0.34	2.14	0.02	2.43	85.25	14.75	6.59	1.25	2.22	4.69	1.05	24.31	3.56
Do	210	Mar., 1882	80.80	1.58	9.89	2.05	1.85	95.38	0.29	1.80	0.03	2.08	84.67	15.33	7.74	1.51	1.91	4.17	1.24	16.59	2.55
Do. (average of 3 specimens)			79.44	1.64	10.25	2.19	2.02	94.60	0.32	2.01	0.02	2.57	85.01	14.99	7.29	1.40	2.21	4.09	1.17	19.65	2.93
Long Island Sound (near New Haven, Conn.)	92	Nov., 1881	78.51	1.86	11.61	1.84	2.52	93.81	0.37	2.29	0.02	3.16	83.64	16.36	8.48	1.23	2.74	3.91	1.36	14.62	2.39
Norwalk, Conn	118	Dec., 1881	81.33	1.52	9.52	1.51	2.10	96.46	0.13	0.79	0.01	2.32	90.01	9.99	4.51	0.65	2.22	2.61	0.72	17.85	1.78
Do	151	Feb., 1882	80.50	1.60	9.97	1.89	2.15	96.32	0.12	0.76	0.02	2.50	89.58	10.42	4.68	0.81	2.35	2.58	0.75	17.05	1.78
Do. (average of 2 specimens)			80.91	1.56	9.75	1.70	2.13	96.39	0.12	0.77	0.02	2.41	89.79	10.21	4.59	0.73	2.29	2.60	0.74	17.45	1.78
Oyster Bay, Long Island Sound, N. Y	108	Nov., 1881	75.22	1.61	10.07	2.87	1.87	94.87	0.29	1.81	0.09	2.33	83.35	16.65	6.65	1.72	2.06	6.22	1.06	20.31	3.38
Do	180	Feb., 1882	77.90	1.70	10.61	2.35	2.19	95.31	0.23	1.46	0.01	2.37	84.37	15.63	7.21	1.48	2.26	4.68	1.15	17.27	2.70
Do. (average of 2 specimens)			76.11	1.66	10.34	2.61	2.03	95.09	0.26	1.64	0.05	2.35	83.86	16.14	6.93	1.60	2.16	5.45	1.11	18.76	3.00
Cow Bay, East River, N. Y	57	Apr., 1881	79.92	1.67	10.44	2.16	1.74	95.44	0.26	1.67	0.02	1.57	87.57	12.43	6.11	1.11	1.66	3.55	0.98	20.28	2.53
Rockaway, N. Y	58	...do	81.27	1.47	9.18	2.13	1.67	95.06	0.26	1.60	0.04	2.26	87.06	12.94	6.02	1.25	1.91	3.76	0.96	18.40	2.38
Do	112	Nov., 1881	77.66	1.68	10.53	2.72	2.02	94.79	0.28	1.76	0.01	2.56	84.33	15.67	7.12	1.67	2.23	4.65	1.14	19.84	3.11
Do. (average of 2 specimens)			79.46	1.58	9.85	2.43	1.85	94.92	0.27	1.68	0.03	2.41	85.69	14.31	6.57	1.46	2.07	4.21	1.05	19.12	2.75
"Blue Points," Patchogue, Long Island, N. Y	56	Apr., 1881	76.77	1.64	10.28	2.30	1.93	94.33	0.37	2.30	0.09	1.91	81.70	18.30	8.04	1.68	1.92	6.66	1.29	18.62	3.41
"Blue Points," Great South Bay, Long Island, N Y	107	Nov., 1881	75.55	2.13	13.31	2.02	2.58	96.89	0.12	0.75	0.01	1.90	88.30	11.70	5.80	0.82	2.18	2.90	0.93	16.17	1.89

"Blue Points," (Long Island Coast, N. Y.?)	182	Feb., 1882	83.97	1.41	8.81	1.62	1.59	96.87	0.16	0.92	0.01	1.70	90.17	9.83	5.01	0.85	1.63	2.34	0.80	15.42	1.52
Do. (average of 3 specimens)			78.76	1.72	10.80	1.98	2.03	96.03	0.21	1.32	0.04	1.84	86.72	13.28	6.28	1.12	1.91	3.97	1.01	16.74	2.28
Staten Island, N. Y	60	Apr., 1881	84.47	1.30	8.14	1.68	1.41	96.35	0.21	1.30	0.09	0.85	89.67	10.33	5.15	0.90	1.16	3.03	0.82	16.23	1.68
Princess Bay, Staten Island, N. Y	109	...do	82.79	1.35	8.41	1.74	1.71	96.64	0.18	1.09	0.01	1.87	90.15	9.85	4.52	0.82	1.80	2.71	0.72	17.59	1.73
Do. (average of 2 specimens)			83.63	1.33	8.28	1.71	1.56	96.49	0.20	1.20	0.05	1.36	89.91	10.09	4.84	0.91	1.48	2.87	0.77	16.91	1.71
Shrewsbury, N. J	61	Apr., 1881	81.65	1.31	8.20	2.20	1.33	95.07	0.33	2.03	0.04	1.83	85.39	14.61	6.48	1.60	1.47	5.06	1.04	17.52	2.55
Do	106	Nov., 1881	77.58	1.55	9.68	2.66	1.88	95.35	0.30	1.88	0.04	1.96	85.17	14.83	6.35	1.54	1.91	5.03	1.02	19.67	2.92
Do	181	Feb., 1882	81.73	1.46	9.15	2.00	1.68	96.52	0.22	1.38	0.01	1.72	89.16	10.84	5.24	1.00	1.69	2.91	0.84	19.23	2.09
Do. (average of 3 specimens)			80.32	1.44	9.01	2.29	1.63	95.65	0.28	1.76	0.03	1.83	86.57	13.43	6.02	1.38	1.69	4.34	0.97	18.81	2.52
Norfolk, Va	59	Apr., 1881	83.86	1.49	9.32	1.45	1.82	96.83	0.17	1.05	0.01	1.64	91.42	8.58	4.19	0.61	1.72	1.76	0.72	11.18	0.96
Potomac River, Va. (transplanted) * †	73	May, 1881	78.87	1.57	9.81	2.27	2.54	95.51	0.23	1.45	0.01	2.47	86.60	13.40	5.93	1.23	2.50	3.74	0.95	12.15	1.63
Potomac River, Va. (transplanted) * ‡ §	84	Nov., 1881	82.06	1.45	9.09	1.93	1.58	95.69	0.33	2.05	0.01	1.19	87.36	12.64	6.37	1.18	1.43	3.66	1.02	16.66	2.11
Potomac River, Va (transplanted) * ‡ ‖	85	.. do	77.90	1.65	10.31	2.33	2.17	94.99	0.29	1.81	0.02	2.47	86.14	13.86	6.20	1.21	2.32	4.13	0.99	16.13	2.24
Do (average of 3 specimens)			79.61	1.56	9.74	2.18	2.10	95.40	0.28	1.77	0.01	2.04	86.70	13.30	6.17	1.21	2.08	3.84	0.99	14.98	1.99
Rappahannock River, Va. (transpld) * † §	72	May, 1881	82.64	1.36	8.51	1.90	1.58	97.24	0.16	1.01	0.01	1.38	89.68	10.32	4.90	0.99	1.48	2.95	0.78	15.17	1.56
James River, Va. (transplanted) * ¶	71	...do	83.49	1.32	8.26	1.78	1.71	95.91	0.19	1.17	0.01	2.56	90.05	9.95	4.53	0.84	2.15	2.43	0.72	13.79	1.37
James River, Va. (transplanted) * ‡ ‖	82	Nov., 1881	77.99	1.70	10.63	2.61	2.21	94.74	0.31	1.95	0.05	2.54	84.15	15.85	7.44	1.66	2.32	4.43	1.19	15.00	2.38
James River, Va. (transplanted) * ‡ ‖	83	...do	82.77	1.40	8.79	1.91	1.55	95.22	0.34	2.09	0.13	1.42	86.95	13.05	6.54	1.31	1.50	3.70	1.05	17.17	2.24
Do. (average of 3 specimens)			81.42	1.47	9.23	2.10	1.82	95.29	0.28	1.74	0.07	2.17	87.05	12.95	6.17	1.27	1.99	3.52	0.99	15.32	2.00
Do. (average of 34 specimens)			80.30	1.56	9.78	2.05	1.99	95.61	0.23	1.48	0.03	2.13	87.13	12.87	6.04	1.17	2.03	3.36	0.97	17.67	2.26
Oysters, "solids" (out of shell): * *																					
Fair Haven, Conn	89	Nov., 1881	84.04	1.14	7.12	1.96	0.86	96.19	0.26	1.60	0.02	0.55	85.21	14.79	6.60	1.77	0.82	5.60	1.05	100.00	14.79
Do	204	Mar., 1882											88.44	11.56	5.91	1.54	0.89	3.22	0.95	100.00	11.56
Virginia (transplanted)*	104	Nov., 1881	85.50	1.20	7.51	1.83	1.12	96.43	0.23	1.43	0.02	0.77	87.23	12.77	6.56	1.54	1.06	3.61	1.05	100.00	12.77
Do *	202	Mar., 1882											87.90	12.10	6.13	1.57	0.77	3.63	0.98	100.00	12.10
Do. (average of 4 samples)													87.20	12.80	6.30	1.60	0.88	4.01	1.01	100.00	12.80
Oysters, "Cove," canned:																					
Chesapeake Bay	74	May, 1881	78.53	2.24	14.08	3.78	1.60	93.57	0.28	1.77	0.27	1.21	86.02	13.98	7.96	2.05	1.41	2.56	1.27	100.00	13.98
Do	97	Nov., 1881	76.75	2.12	13.29	4.35	1.63	93.35	0.22	1.40	0.09	0.91	85.15	14.85	7.29	2.20	1.28	4.08	1.17	100.00	14.85
Do	120	...do	77.25	2.10	13.12	4.24	1.45	90.57	0.31	1.92	0.12	1.10	84.60	15.40	6.97	1.97	1.25	5.21	1.11	100.00	15.40
Do. (average of 3 samples)			77.51	2.15	13.50	4.12	1.56	92.50	0.27	1.70	0.16	1.08	85.26	14.74	7.41	2.07	1.31	3.95	1.18	100.00	14.74
Scallops (Pecten irradians): ††																					
Shelter Island, N. Y	51	Mar., 1881	77.79	2.41	15.05	0.03	1.48						77.79	22.21	15.05	0.03	1.48	5.65	2.41	100.00	22.21
Do	63	Apr., 1881	82.84	2.31	14.44	0.30	1.29						82.84	17.16	14.44	0.30	1.29	1.13	2.31	100.00	17.16
Do. (average of 2 specimens)			80.32	2.36	14.75	0.17	1.38						80.32	19.68	14.75	0.17	1.38	3.38	2.36	100.00	19.86
Long clams (Mya arenaria), in shell:																					
Boston, Mass	67	May, 1881	77.96	2.33	14.55	1.79	2.76	95.74	0.08	0.49	0.01	3.29	86.09	13.91	8.12	0.98	3.00	1.81	1.30	53.90	7.50
Clinton, Conn	102	Nov., 1881	78.57	2.38	14.86	1.78	2.49	96.02	0.11	0.65	0.00	2.81	86.11	13.89	8.71	1.01	2.63	1.54	1.39	57.92	8.05
Do	201	Mar., 1882	79.94	2.02	12.62	1.69	3.11	96.77	0.11	0.67	0.01	2.05	85.00	15.00	9.03	1.19	2.79	1.99	1.44	56.30	8.44
Do (Average of 2 specimens, Clinton)			79.26	2.20	13.74	1.74	2.80	96.40	0.11	0.66	0.01	2.43	85.56	14.44	8.86	1.09	2.71	1.78	1.41	57.11	8.25
Long Island, N. Y	65	Apr., 1881	81.05	2.00	12.52	1.52	1.56	94.76	0.21	1.30	0.03	2.93	86.10	13.90	8.39	0.97	2.06	2.48	1.34	57.64	8.02
Average of 4 specimens			79.38	2.18	13.64	1.69	2.48	95.82	0.17	0.78	0.01	2.77	85.82	14.18	8.56	1.04	2.62	1.96	1.38	56.44	8.00
Long clams, canned:																					
Penobscot Bay, Maine	122	Nov., 1881	74.63	2.84	17.73	2.89	3.16	91.92	0.40	2.49	0.04	1.72	84.54	15.46	9.00	1.26	2.34	2.86	1.44	100.00	15.46

* To New Haven, Conn.
† Taken from beds about three weeks after transplanting.
‡ About six months after transplanting.
§ Floated.
‖ Not floated.
¶ About five weeks after transplanting.
** *i. e.* Shell-contents, including flesh and liquids.
†† The adductor muscle the portion ordinarily eaten.

TABLE 35.—*Analyses of mollusks, crustaceans, etc., calculated on fresh substance*—Continued.

Name and locality of specimen.	Laboratory No. of specimen.	Specimen received.	Edible portion. In flesh. Water.	In flesh. Nitrogen.	In flesh. Protein (nitrogen × 6.25).	In flesh. Fat (ether extract).	In flesh. Crude ash.	In liquids. Water.	In liquids. Nitrogen.	In liquids. Protein (nitrogen × 6.25).	In liquids. Fat (ether extract).	In liquids. Crude ash.	In edible portion (flesh plus liquids). Water.	Water-free substance.	Protein (nitrogen × 6.25).	Fat (ether extract).	Crude ash.	Extractives.	Nitrogen.	In whole sample. Total edible portion. (From Table 33.)	In whole sample. Total water-free subst'ce, actual nutrients.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Round clams (Venus mercenaria), in shell:																					
Little Neck, N. Y.	66	Apr., 1881	78.24	1.86	11.59	0.74	2.22	95.12	0.14	0.90	0.02	3.17	86.18	13.82	6.52	0.40	2.66	4.24	1.05	31.71	4.39
Round clams, canned:																					
Islip, Long Island, N. Y.	125	Nov., 1881	75.56	2.67	16.70	1.27	2.33	90.52	0.65	4.07	0.26	3.26	82.96	17.04	10.45	0.77	2.79	3.03	1.67	100.00	17.04
Mussels (Mytilus edulis), in shell:																					
Stony Creek, Conn.	139	Dec., 1881	78.67	2.00	12.51	1.67	1.73	94.23	0.28	1.77	0.13	2.23	84.20	15.80	8.69	1.12	1.91	4.08	1.39	50.66	8.01
Lobster (Homarus americanus), in shell:																					
Locality unknown (Maine or Massachusetts?)	50	Mar., 1881											84.30	15.70	11.63	1.82	1.63	0.62	1.86	52.52	8.25
Do	62	Apr., 1881											81.77	18.23	14.05	1.55	1.71	0.92	2.24	36.24	6.60
Do	239	Apr., 1882											79.17	20.83	17.24	1.45	1.62	0.52	2.76	32.24	6.72
Do	69	May, 1881											82.11	17.89	15.03	2.54	1.87	(*)	2.41	30.56	5.47
Do. (average of 4 specimens, lobsters)													81.84	18.16	14.49	1.84	1.71		2.32	37.89	6.76
Lobster, canned:																					
Maine	76	May, 1881											79.36	20.64	16.75	0.46	2.78	0.65	2.68	100.00	20.64
Do	121	Nov., 1881											76.15	23.85	19.52	1.68	2.15	0.50	3.12	100.00	23.85
Do. (average of 2 samples)													77.75	22.25	18.13	1.07	2.47	0.58	2.90	100.00	22.25
Crayfish (Cambarus), in shell:																					
Potomac River, Virginia	64	Apr., 1881											81.22	18.78	16.00	0.46	1.31	1.01	2.56	12.30	2.31
Crab (Callinectes hastatus), in shell:																					
New Jersey	101	Nov., 1881											77.07	22.93	16.64	1.96	3.13	1.20	2.66	44.16	10.13
Crabs, canned:																					
Hampton, Va	124	Nov., 1881											80.98	19.02	15.62	0.79	1.78	0.83	2.50	100.00	19.02
Do	274	Apr., 1882											78.95	21.05	15.98	2.30	2.10	0.67	2.56	100.00	21.05
Do (average of 2 samples of canned crabs)													79.97	20.03	15.80	1.54	1.94	0.75	2.53	100.00	20.03
Shrimp, canned:																					
Gulf of Mexico	123	Nov., 1881											70.80	29.20	25.38	1.00	2.58	0.24	4.06	100.00	29.20
Terrapin, in shell:																					
Savannah, Ga	235	Apr., 1882											74.47	25.53	21.23	3.47	1.02	(†)	3.40	20.97	5.35
Green turtle (Chelonia mydas), in shell:																					
Key West, Fla	272	May, 1882											79.78	20.22	19.84	0.53	1.20	(‡)	3.17	24.03	4.86

* Water + protein + fat + ash = 101.55. "Extractives" = —1.55. † "Extractives" = —0.19. ‡ "Extractives" = —1.35.

TABLE 36.—*Percentages of phosphoric and sulphuric acids in flesh of mollusks and crustaceans.*

Name and locality of specimen.	Laboratory No. of specimen.	In water-free substance.					In fresh substance.				
		Phosphoric acid.		Sulphuric acid.			Phosphoric acid.		Sulphuric acid.		
		Total phosphorus calculated as (P_2O_5).	Total phosphorus calculated as (PO_4).	Total sulphur calculated as (SO_3).	Total sulphur calculated as (SO_4)	Chlorine.	Total phosphorus calculated as (P_2O_5).	Total phosphorus calculated as (PO_4).	Total sulphur calculated as (SO_3).	Total sulphur calculated as (SO_4).	Chlorine.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*P. ct.*
Oysters (Ostrea virginica):											
Buzzard's Bay, Mass	68	1.48	1.98	4.15	4.98	3.53	0.23	0.31	0.64	0.77	0.56
Providence River, R. I	70	1.64	2.20	3.55	4.26	2.39	0.34	0.46	0.74	0.89	0.50
Stony Creek, Conn	55	1.46	1.96	5.31	6.37	4.30	0.28	0.37	1.01	1.21	0.82
Do	75	1.77	2.37	3.65	4.37	3.70	0.32	0.44	0.81	0.97	0.66
Do ... Average of 2 specimens	....	1.62	2.17	4.48	5.38	4.00	0.30	0.40	0.91	1.09	0.74
Fair Haven, Conn	54	1.57	2.10	5.59	6.71	3.11	0.29	0.39	1.05	1.26	0.58
Blue Point, N. Y	56	1.28	1.71	3.70	4.44	1.96	0.30	0.40	0.86	1.03	0.46
Rockaway, N. Y	58	1.59	2.13	3.89	4.67	2.81	0.30	0.40	0.73	0.88	0.53
Long Island Sound, N. Y	60	1.98	2.65	3.19	3.83	1.98	0.31	0.41	0.49	0.59	0.31
East River, N. Y	57	1.62	2.17	5.01	6.01	2.94	0.32	0.44	1.00	1.20	0.59
Shrewsbury, N. J	61	1.61	2.16	2.23	2.68	1.58	0.30	0.40	0.41	0.49	0.29
Norfolk, Va	59	1.79	2.39	2.28	2.74	2.76	0.29	0.39	0.46	0.55	0.45
Potomac River, Va. Transplanted to New Haven, Conn	73	1.75	2.35	2.59	3.11	3.18	0.37	0.50	0.55	0.66	0.67
Rappahannock River, Va. Transplanted to New Haven, Conn	72	1.80	2.40	2.13	2.56	1.93	0.31	0.41	0.37	0.44	0.34
James River, Va. Transplanted to New Haven, Conn	71	1.79	2.39	2.78	3.34	3.24	0.30	0.40	0.46	0.55	0.54
Oysters, canned:											
Chesapeake Bay	74	1.62	2.17	0.94	1.13	2.56	0.35	0.47	0.20	0.24	0.55
Scallops (Pecten irradians):											
Shelter Island, N. Y	51	2.17	2.91	2.23	2.68	1.76	0.48	0.64	0.50	0.60	0.39
Do	63	2.75	3.68	2.76	3.32	1.87	0.47	0.63	0.47	0.56	0.32
Do ... Average of 2 specimens	....	2.46	3.29	2.49	2.99	1.82	0.48	0.64	0.49	0.59	0.36
Long clams (Mya arenaria):											
Boston, Mass	67	2.21	2.95	3.14	3.77	2.98	0.48	0.64	0.69	0.83	0.66
Long Island, N. Y	65	2.48	3.31	2.35	2.82	1.84	0.47	0.63	0.44	0.53	0.35
Average of 2 specimens	....	2.35	3.14	2.75	3.30	2.41	0.48	0.64	0.56	0.67	0.51
Round clams (Venus mercenaria):											
Little Neck, N. Y	66	1.86	2.48	4.11	4.93	3.22	0.40	0.53	0.89	1.07	0.70
Lobster (Homarus americanus):											
Maine	50	2.13	2.87	2.39	2.87	4.35	0.33	0.45	0.38	0.45	0.68
Do	62	2.24	2.98	1.97	2.36	3.23	0.41	0.54	0.36	0.43	0.59
Massachusetts	69	2.35	3.14	3.06	3.67	2.81	0.40	0.53	0.53	0.64	0.50
Average of 3 specimens	....	2.24	2.98	2.47	2.97	3.46	0.38	0.51	0.42	0.50	0.59
Lobster, canned:											
Maine	76	1.13	1.51	2.34	2.81	5.05	0.23	0.31	0.48	0.58	1.04
Crayfish (Cambarus):											
Potomac River, Va	64	2.85	3.81	1.39	1.67	1.44	0.53	0.71	0.26	0.31	0.27

4. EFFECT OF OSMOSE UPON THE CONSTITUENTS OF OYSTERS. CHANGES IN COMPOSITION IN THE PROCESS OF FLOATING, I. E., REMOVAL FROM SALT TO BRACKISH OR FRESH WATER.

It is a common practice of oyster dealers, instead of selling the oysters in the condition in which they are taken from the beds in salt water, to first place them for a time (forty-eight hours, more or less) in fresh or brackish water, in order, as the oystermen say, to "fatten" them, the operation being called "floating" or "laying out." By this process the body of the oyster acquires such a plumpness and rotundity, and its bulk and weight are so increased, as to materially increase its selling value.

The study of this matter has a scientific as well as practical interest. It is commonly assumed that the passage of the digested materials through the walls of the alimentary canal in the bodies of animals is in large part due to osmose or dialysis and that the operation of this physical law is very common in living organisms. The quantitative study of the chemical changes involved in these processes is generally rendered difficult or impossible by the very fact of their going on in living bodies where the application of chemical analysis is impossible. An opportunity is, however, given in the case of the oyster.

The following experiments were made with oysters supplied by Mr. F. T. Lane, of New Haven, Connecticut, for whose courteous aid, as well in furnishing the specimens as in giving useful information, I take this occasion to express my thanks.

The oysters had been brought from the James and Potomac Rivers and "planted" in the beds in New Haven harbor (Long Island Sound) in April, 1881, and were taken for analysis in the following November.

Two series of experiments were made. The plan of each consisted in analyzing two specimens, both of which had been taken from the same bed at the same time, but one had been "floated" while the other had not. The first specimen was selected from a boat-load as they were taken from the salt water, and the second from the same lot after they had been "floated" in the usual way in brackish water for forty-eight hours. The separations and weighing of shells, flesh, liquor, etc., and the analyses of flesh and liquors, were made as described in the chapter on methods of analysis. It will suffice to say here briefly that the specimens were weighed as received at the laboratory, the shell contents were then taken out and the shells, flesh (body or solid portion), and liquids (liquid portion) weighed separately. The whole weight, less the sum of the weights of shells, flesh, and liquids, gave the amount of loss in the preparation for analysis, which loss was doubtless, for the most part, adhering water, though a part must, of course, have been due to evaporation. The statistics of the weights of the constituents and of the whole specimens are given in Table 37.

TABLE 37.—*Statistics of weights, etc., of specimens of oysters.*

Constituents.	James River.*				Potomac River.*			
	From beds.		From floats.		From beds.		From floats.	
	Lab. No. 82; 31 oysters.		Lab. No. 83: 34 oysters.		Lab. No. 85; 35 oysters.		Lab. No. 84; 41 oysters.	
	Grms.	*Lbs. Oz.*	*Grms.*	*Lbs. Oz.*	*Grms.*	*Lbs. Oz.*	*Grms.*	*Lbs. Oz.*
Shell contents:								
Flesh (body)	312.5	11.0	412.5	14.5	302.5	10.7	415.5	14.7
Liquids (liquor)	181.5	6.4	208.0	7.3	282.0	10.0	264.3	9.3
Total	494.0	1 1.4	620.5	1 5.8	584.5	1 4.7	679.8	1 8.0
Refuse:								
Shells	2778.0	6 2.0	2976.0	6 9.1	3017.0	6 10.4	3386.0	7 7.4
Loss †	21.0	0.8	17.5	0.6	22.5	0.8	15.2	0.5
Total	2799.0	6 2.8	2993.5	6 9.7	3039.5	6 11.2	3401.2	7 7.9
Total weight of specimen	3293.0	7 4.2	3614.0	7 15.5	3624.0	7 15.9	4081.0	8 15.9

* Transplanted to beds in New Haven harbor, Connecticut, in April, and taken for analysis the following November.
† Loss in opening and weighing, chiefly water.

The flesh and liquids were analyzed separately. From the results of the analyses, of which the details with those of the weighings are stated in full under Nos. 82–85, in the chapter on details of analyses of invertebrates, the composition of the several constituents and of the whole specimen were calculated. The results are set forth in Table 38, viz:

TABLE 38.—*Comparative percentage composition of oysters before and after "floating."*

Constituents of oysters.	James River oysters transplanted to New Haven.		Potomac River oysters transplanted to New Haven.	
	As taken from beds.	As taken from floats.	As taken from beds.	As taken from floats.
	No. 82.	No. 83.	No. 85.	No. 84.
In whole specimen:				
Shell contents:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Flesh	9.49	11.41	8.35	10.18
Liquids	5.51	5.76	7.78	6.48
Total shell contents	15.00	17.17	16.13	16.66
Refuse:				
Shells	84.36	82.35	83.25	82.97
Loss in preparation for analysis	0.64	0.48	0.62	0.37
Total refuse	85.00	82.83	83.87	83.34
Total constituents, shell contents and refuse	100.00	100.00	100.00	100.00
In flesh (body):				
Water	77.99	82.77	77.90	82.06
Water-free substance	22.01	17.23	22.10	17.94
Total flesh	100.00	100.00	100.00	100.00
In water-free substance:				
Nitrogen	1.70	1.40	1.65	1.45
Protein (nitrogen × 6.25)	10.63	8.79	10.31	9.09
Fat (ether extract)	2.61	1.91	2.33	1.93
Ash	2.21	1.55	2.17	1.58
Carbohydrates, etc. (by difference)	6.56	4.98	7.29	5.34
Total water-free substance	22.01	17.23	22.10	17.94

TABLE 38.—*Comparative percentage composition of oysters before and after "floating"*—Continued.

Constituents of oysters.	James River oysters transplanted to New Haven.		Potomac River oysters transplanted to New Haven.	
	As taken from beds.	As taken from floats.	As taken from beds.	As taken from floats.
	No. 82.	No. 83.	No. 85.	No. 84.
In liquids:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Water	94.74	95.22	94.99	95.69
Water-free substance	5.26	4.78	5.01	4.31
Total liquids	100.00	100.00	100.00	100.00
In water-free substance:				
Nitrogen	0.31	0.34	0.29	0.33
Protein (nitrogen × 6.25)	1.95	2.09	1.81	2.05
Fat (ether extract)	0.04	0.13	0.02	0.01
Ash	2.54	1.42	2.47	1.19
Carbohydrates, etc. (by difference)	0.73	1.14	0.71	1.06
Total water-free substance	5.26	4.78	5.01	4.31
In total shell contents, flesh and liquids:				
Water	84.15	86.95	86.14	87.36
Water-free substance	15.85	13.05	13.86	12.64
Total shell contents	100.00	100.00	100.00	100.00
In water-free substance:				
Nitrogen	1.19	1.05	0.99	1.02
Protein (nitrogen × 6.25)	7.44	6.54	6.20	6.37
Fat (ether extract)	1.66	1.31	1.21	1.18
Ash	2.32	1.50	2.32	1.43
Carbohydrates, etc. (by difference)	4.43	3.70	4.13	3.66
Total water-free substance	15.85	13.05	13.86	12.64
In whole specimen:				
Shell contents:				
Water	12.62	14.93	13.89	14.55
Water-free substance	2.38	2.24	2.24	2.11
Total shell contents	15.00	17.17	16.13	16.66
Refuse	85.00	82.83	83.87	83.34
Total shell contents and refuse	100.00	100.00	100.00	100.00
Shell contents:				
Nitrogen	0.18	0.18	0.16	0.17
Protein (nitrogen × 6.25)	1.12	1.12	1.00	1.06
Fat (ether extract)	0.25	0.22	0.20	0.20
Ash	0.35	0.26	0.37	0.24
Carbohydrates, etc. (by difference)	0.66	0.64	0.67	0.61
Total water-free substance	2.38	2.24	2.24	2.11
Water	12.62	14.93	13.89	14.55
Total shell contents	15.00	17.17	16.13	16.66

Regarding the results of these analyses it should be said that—

1. Of course the figures can not claim absolute accuracy; but for the reasons to be set forth in the discussion of the methods of analysis just referred to, I am persuaded that the errors due to imperfections of method or manipulation can not be very large.

2. The protein is estimated by multiplying the percentage of nitrogen by 6.25. The correctness of this factor for the oyster has not been verified. We know very little about the nitrogenous constituents of the oyster at best, and the uncertainties are here greater than in analyses of

muscular tissue (flesh) of fishes or mammals, not only because of lack of information regarding the nitrogenous compounds in the muscle of the oyster, but also because the other tissues and fluids, including the products of secretion and excretion, and with them the liquids, are analyzed. The liquids consist of the fluids contained within the shells but outside the body, together with whatever blood may have flowed out of the wounds made in separating the body from the shell, or rather of so much of these as drained off from the body and shell in the preparation for analysis. In all of these latter substances we have to do with materials about the composition of which extremely little is known. All that can be said for the figures for protein, therefore, is that they are based upon the amounts of nitrogen as found in the analyses; that the nitrogen determinations were made with soda-lime, but by methods of manipulation which have been tested in this laboratory by numerous comparisons with the absolute and Kjeldahl methods; and that as a measure of the comparative amounts of true protein compounds (albuminoids and gelatinoids) in the body they are, presumably, not very far out of the way.

The determinations of fat represent the amounts of material extracted by warm ether from the residue left after evaporating the flesh and liquids, at a temperature of about 96°, nearly to dryness (so far that the mass was friable and easily pulverized). The flesh was dried in hydrogen, and the liquids in air. I can not vouch for the correctness of the assumption that this ether extract consists entirely of fatty matters, but until the opportunity comes for investigating the subject more closely I see no better way than to simply state the results as we found them.

The determinations of ash and of water I judge to be reasonably accurate. Our experience with the methods employed has given us confidence in their reliability within tolerably narrow limits. I should explain also that all the determinations except water were first computed upon the water-free substance and then calculated over upon fresh substance.

The extractives were estimated by subtracting the sum of the protein, fats, and ether extract from the total water-free substance. It is plain that any errors in the estimates of the other ingredients will, unless they balance each other, affect the estimate of the extractives. The actual substances which the figures for extractives thus approximately represent in the flesh I presume to consist chiefly of the carbohydrates (glycogen) of the liver, which makes up a large portion of the body of the animal.

CHANGES IN COMPOSITION PRODUCED BY FLOATING.

As was to be expected, the sojourn in fresher water resulted in an increase in the percentage of total shell contents. The principal gain was in the flesh, which naturally lost some mineral salts but gained much more water, so that its actual percentage increased. The increase was in one case from 9.49 to 11.41, and in the other from 8.35 to 10.18

per cent. of the total weight. The liquids showed in one case an increase from 5.51 to 5.76 per cent., and in the other a decrease from 7.78 to 6.48 per cent. This disparity, however, is not to be wondered at when we consider that the liquids are very little affected by the dialysis, but are doubtless swept away by the surrounding water to greater or less extent in proportion as the valves are more or less opened and the current is stronger or weaker.

The figures for the composition of the flesh show more exactly how the gain in quantity is brought about by gain of water. The water in the flesh increases in one case from 78.0 to 82.8, and in the other from 77.9 to 82.1 per cent., the percentages of water-free substance decreasing, of course, in corresponding degree during the dialysis. The variations in the several ingredients will appear more clearly if we compute the increase or decrease of each in per cent. of its own percentage in the flesh before the osmose.

For example, flesh of the James River oysters contained before the dialysis 10.63 per cent. of protein (N $\times$ 6.25), and after dialysis 8.79 per cent. The difference (10.69 — 8.79) is 1.84 per cent. This difference, 1.84, is 17.3 per cent. of 10.63, the percentage of protein in the flesh before dialysis. In other words, the protein has fallen off 17.3 per cent. of its amount before dialysis. The proportions of the several ingredients of the flesh thus gained and lost in the two cases may be tabulated as follows:

TABLE 39.—*Gain and loss of ingredients of flesh (body) of oysters during dialysis in "floating."*

Ingredients of flesh	Percentages of ingredients found by analysis.		Gain (+) or loss (—) during dialysis.	
	Before dialysis.	After dialysis.	Expressed in difference of percentages, before and after dialysis.	Expressed in percentages of the percentages in flesh before dialysis.
James River:				
Water	77.99	82.77	+4.78	+6.1
Water-free substance	22.01	17.23	—4.78	—21.7
Protein (N $\times$ 6.25)	10.63	8.79	—1.84	—17.3
Fats (ether extract)	2.61	1.91	—0.70	—26.8
Carbohydrates, etc	6.56	4.98	—1.58	—24.1
Ash	2.21	1.55	—0.66	—29.9
Potomac River:				
Water	77.90	82.06	+4.16	+5.3
Water-free substance	22.10	17.94	—4.16	—18.8
Protein (N $\times$ 6.25)	10.31	9.09	—1.22	—11.8
Fats (ether extract)	2.33	1.93	—0.40	—17.8
Carbohydrates, etc	7.29	5.34	—1.95	—26.8
Ash	2.17	1.58	—0.59	—27.2

The gain of water as expressed in the excess of the percentage in the floated over that of the not-floated specimen is 4.78 (which is, of course, the same as the loss of water-free substance). This 4.78 is 6.1 per cent. of the 77.79 per cent. of water in the not-floated specimen. In other words, the percentage of water was increased in the process of osmose by 6.1 per cent. of its amount before the osmose. The corre-

sponding loss of water-free substance, 4.78, is 21.7 per cent. of 22.01, the per cent. of water-free substance before dialysis. That is to say, the water-free substance fell off by 21.7 per cent. of its amount. Among the ingredients of the water-free substance the smallest of these loss percentages is in that of the protein, 17.3; the largest in that of the ash (mineral salts), 29.9. It is interesting to note that not only the extractives but the fats also show larger loss percentages than the protein, that of the fats, 26.8, being almost as great as that of the mineral salts.

In the Potomac oysters the loss percentages are a little smaller and not exactly parallel, since in this case the loss of the extractives is larger than that of the fats. The percentages of fats are, however, so very small that these variations may very likely be due in large part to errors of analysis.

It may not be uninteresting to note how these loss percentages stand in the liquids and in the whole shell contents as well as in the flesh. The calculations in the accompanying table are made in the same way as those in the previous table, except that the averages are also given.

TABLE 40.—*Gain (+) or loss (—) of ingredients of flesh, liquids, and total shell contents of oysters in floating.*

[Estimated by comparing percentages before and after dialysis and expressed in percentages of the percentages of the ingredients before dialysis.]

Constituents.	In flesh.			In liquids.			In shell contents.		
	James River.	Potomac River.	Average.	James River.	Potomac River.	Average.	James River.	Potomac River.	Average.
Water	+ 6.1	+ 5.3	+ 5.7	+ 0.5	+ 0.7	+ 0.6	+ 3.3	+ 1.4	+ 2.9
Water-free substance	—21.7	—18.8	—20.3	— 9.1	—14.0	—11.6	—17.6	— 8.9	—13.2
Protein	—17.3	—11.8	—14.5	+7.1	+13.2	+10.1	—12.1	+ 2.7	— 4.7
Fats	—26.8	—17.8	—22.0	(*)	(*)	(*)	—21.1	— 2.5	—11.8
Carbohydrates, etc	—24.1	—26.8	—25.4	+58.3	+49.3	+53.8	—16.5	—11.3	—13.9
Ash	—29.9	—27.2	—28.6	—44.1	—51.8	—47.9	—35.3	—38.3	—36.8

* The quantities of fats in the liquids were so minute that they are omitted in this computation.

Perhaps the most noticeable change in the composition of the liquids in the floating is the increase in the percentage of protein and extractives. The increase of water and decrease of total water-free substance are what we might anticipate, but the considerable gain of protein and non-nitrogenous extractives which accompanies the gain of water and loss of salts seems, at first sight, rather strange. Although the absolute quantities of protein and carbohydrates involved are small, the differences which represent the increase are far outside the limits of error of analysis. It is, of course, true that the figures above cited represent percentages only, and do not tell whether the total amounts of protein and extractives in the liquids after floating were larger or smaller than before floating. It is, therefore, possible that the absolute content of protein and fats in the liquids may have remained unchanged or even grown smaller, but it seems hardly natural to suppose that such changes

as these could occur in the percentages unless the liquids had received protein and extractives from the flesh.

An explanation of a way in which such an accession of these ingredients may have come about has been suggested by my colleague, Professor Conn, who calls attention to the fact that some mollusks, when irritated, produce an extremely abundant secretion of mucus or "slime;" so much, indeed, as to sometimes render a small quantity of water in which the animals may be confined quite sensibly gelatinous. He suggests that the change to fresh water may induce such a secretion of mucus and perhaps of carbohydrates and fats as well, which would account for the increase of these substances in the liquids. The observation of oyster dealers that "water always thickens the natural juices that adhere to the surface of the oyster and makes it slimy," accords with Professor Conn's statement.

I have attempted to estimate the probable amount of absolute gain and loss of constituents of the liquids during the floating, by methods analogous to those employed for the flesh, as will be explained beyond; but the data at hand do not seem sufficient to make the estimate at all satisfactory. It may not be amiss to mention, however, that if we assume the weight of the shells to have remained unchanged, and on this assumption calculate the absolute amounts from the percentage composition, the total amounts of liquids appear in one experiment to grow larger, and in the other to grow smaller during the floating. The same calculation makes the protein increase in one case and decrease in the other. But the changes are very small in all the cases, and the impression left upon my mind after this weighing of probabilities is, that the apparent gain of protein and extractives in the liquids is of no very great moment. The reason for saying so much about it is its possible bearing upon the estimates of changes in the flesh, as will appear beyond.

ABSOLUTE INCREASE AND DECREASE OF CONSTITUENTS DURING THE FLOATING—CHANGES IN FLESH.

Enough has been said to illustrate the desirability of knowing how the actual weights of the shell-contents and of their several constituents before and after floating compare. If these data could be exactly obtained the actual gain or loss of each would, of course, be made certain. The desired determinations could be made with tolerable exactness by taking a sufficiently large number of oysters from the beds, dividing them in two lots of equal number and weight, floating one lot and analyzing both. The outlay of labor and money which this plan would have required was, unfortunately, larger than the circumstances permitted. In lack of such experiments we may, I think, make a tolerably correct estimate of the gain and loss of flesh and its ingredients in the experiments already described.

If we know the actual increase of weight of the flesh, the calculation of its absolute changes from the percentages shown by analyses would be simple. If there were any constituent whose absolute weight had remained constant, comparison of its percentages in the two specimens of flesh would give the desired data. I am inclined to think the protein very nearly fulfills this condition. The statements above show the probability that some of the protein, *i. e.*, nitrogenous material, left the flesh and went into the liquids during the floating, but this quantity, though it may have been considerable in comparison with the amount in the liquids before dialysis, must, it would seem, have been very small in comparison with the amount of nitrogenous material in the flesh. Of course this is only an assumption, but it seems a very probable one. The loss by metabolism and excretion of metabolized products in forty-eight hours by so inactive an animal as the oyster we should naturally expect to be very small indeed. Dr. Conn tells me that the animals live and thrive for months when their only source of nourishment is from water by which they are moistened only at long intervals and for a few hours at a time by exceptionally high tides, circumstances which preclude anything more than an extremely small food supply and in which, consequently, the metabolism must be very slight. In brief, it seems to me that we shall probably not go far astray in assuming that the whole amount of nitrogen given off from the body during the forty-eight hours in which the dialysis is taking place must be very small indeed as compared with the amount in the body (flesh) of the animal.

If, then, we assume that the amount of nitrogen remains constant during the dialysis the decrease in percentage of nitrogen, *i. e.*, protein, in the flesh during dialysis may be considered as due to the increase of total weight of flesh and will furnish a measure of that gain in weight.

Thus in the body of the James River oyster the percentages of protein before and after dialysis were, respectively, 10.63 and 8.79. That is to say, assuming the body to have neither gained nor lost protein during dialysis, 100 parts which before dialysis contained 10.63 parts of protein must during dialysis have increased to such a weight as to reduce the percentage to 8.79, and this weight must be to 100 as 8.79 to 10.63, which would give 120.93 as the weight after dialysis of the same flesh which before dialysis weighed 100. Accordingly, if we take the percentages found by analysis in the dialyzed flesh and multiply them by 1.2093, we shall have the absolute quantities of each of the several constituents after dialysis in the flesh which before dialysis weighed 100, and the quantities of whose constituents are the percentages shown by the analysis. Thus the 77.99 per cent. of water multiplied by 1.2093 give 100.09, and 100.09—77.99=22.10, the absolute gain of water in the dialysis. As 22.10 is 28.34 per cent of 77.99, the water was increased by 28.34 per cent of its amount by the dialysis. The table which follows gives a statement of calculations made in this manner.

TABLE 41.—*Increase and decrease of weights of flesh and its ingredients in floating.*

[Weights after floating estimated on assumption that the weight of the protein remained unchanged.]

Ingredients of flesh.	Weights of ingredients in 100 grammes of flesh before floating.	Estimated weights of same flesh and of its ingredients after floating.	Gain (+) or loss (—) of weight during floating.	
			Absolute.	In percentages of weights before floating.
In James River specimen:	*Grms.*	*Grms.*	*Grms.*	*P. ct.*
Water	77.99	100.09	+22.10	+28.34
Water-free substance	22.01	20.84	— 1.17	— 5.32
Total flesh	100.00	120.93	+20.93	+20.93
In water-free substance:				
Protein	10.63	10.63		
Fat	2.61	2.31	—0.30	—11.49
Carbohydrates, etc	6.56	6.03	—0.53	— 8.08
Mineral salts	2.21	1.87	—0.34	—13.57
Total water-free substance	22.01	20.84	—1.17	— 5.32
In Potomac River specimen:				
Water	77.90	93.07	+15.17	+19.47
Water-free substance	22.10	20.35	— 1.75	— 7.92
Total flesh	100.00	113.42	+13.42	+13.42
In water-free substance:				
Protein	10.31	10.31		
Fat	2.33	2.19	—0.14	— 6.01
Carbohydrates, etc	7.29	6.06	—1.23	—16.87
Mineral salts	2.17	1.79	—0.38	—17.52
Total water-free substance	22.10	20.35	—1.75	— 7.92
In average of two specimens:				
Water	77.95	96.58	+18.63	+23.90
Water-free substance	22.05	20.59	— 1.46	— 6.62
Total flesh	100.00	117.17	+17.17	+17.28
In water-free substance:				
Protein	10.47	10.47		
Fat	2.47	2.25	—0.22	— 8.75
Carbohydrates, etc	6.92	6.04	—0.88	—12.48
Mineral salts	2.19	1.83	—0.36	—15.54
Total water-free substance	22.05	20.59	—1.46	— 6.62

This computation, like that of the previous table, indicates an absolute gain of water and loss of water-free substance, fats, extractives, and mineral salts. Here, as before, the loss of fats and extractives is particularly large. The fats lose but little less, and the carbohydrates, etc., considerably more than the mineral salts.

The flesh of the James River specimen increased by dialysis from 100 to 121, *i. e.*, gained 21 per cent. in weight. The Potomac specimen gained 13.4 per cent. How these computations would compare with practical experience I have no means of learning exactly, since the oystermen's estimates include both flesh and liquids, while these apply only to the flesh. But, as stated beyond, the increase in weight does not appear to be much larger than is usual in practice.

As the assumption upon which these computations are made, namely, that the amount of protein (nitrogen) in the flesh remains constant during dialysis, is not absolutely correct, it will be worth while to note how the error must affect the calculations.

The factor used for computing the quantities of flesh and its constituents after dialysis was obtained by dividing the percentage of protein in the not-dialyzed by that in the dialyzed flesh. In the James River specimen the figures were $10.63 \div 8.79 = 1.21$ (1.2093). The percentages in the dialyzed specimen multiplied by this factor gave the absolute quantities after dialysis corresponding to 100 before dialysis. In the case of the protein we have $8.79 \times 1.2093 = 10.63$, implying no change. If, now, the protein, instead of remaining constant during dialysis, suffered loss, the correct figures for absolute gain and loss should show a loss of protein; in other words, the factor, to be correct, should itself be smaller. The smaller factor would give smaller weights of flesh and flesh constituents after dialysis, which would reduce the computed gain of flesh and of water and would make the loss of water-free substance, protein, fats, extractives, and ash greater. That is to say, if the body lost nitrogen during dialysis the actual gain of total weight of flesh and the gain of water of flesh must have been less, and the loss of water-free substance, protein, fats, extractives, and ash must have been greater than the figures in the table imply.

If, on the other hand, the body gained nitrogen during the dialysis the actual gain of total flesh and water must have been greater, and the actual loss of water-free substance and its constituents must have been less than the computations imply. It is extremely improbable that the oysters could materially increase their store of protein from any food they could get from the fresher water. The increase of protein in the liquids was apparently at the expense of that of the flesh, as above explained. On the whole, then, it seems reasonable to assume a very small loss of protein. Unless, therefore, there is a decided error in the assumptions made, the conclusion is unavoidable that the actual losses of water-free substance and of each of its ingredients could not have been less, and were probably somewhat more, than the figures in the table for absolute changes in dialysis represent.

So far as I can learn, the change in weight of oysters in the ordinary process of floating is fully as large or larger than in the cases here reported. According to such data as I have been able to obtain, oysters ordinarily increase from one-eighth to one-fifth in bulk in "floating," the latter proportion being common with "good, fat oysters." The increase in weight, which would correspond very nearly to the increase in volume, was computed in the above cases to be, in one case, one-fifth (21 per cent.), and in the other, between one-seventh and one-eighth (13½ per cent). That the oyster absorbs the more water the salter it is, is fully supported by all the experience of which I have accounts and accords entirely with what would be expected in dialysis.

Without entering into the theory of osmose, which is abundantly discussed in the text books, or speculating as to how much of the changes in the flesh was due to osmose and how much to secretion, it will suffice here to briefly recapitulate the results observed.

When the oysters, with their tissues presumably impregnated by the salts of the water in which they have lived, were placed in fresher water, their bodies gained water and lost not only salts but fats and carbohydrates also. The gain of water and loss of salts is naturally explained by the outflow of the more concentrated and inflow of dilute solution of salts in which the dialysis consists. I find it difficult to explain the loss of so much fats and carbohydrates by metabolism and discharge of metabolized products, nor does it seem natural to suppose that carbohydrates and fats would be dialyzed out of the body so much more rapidly in the brackish water than in the salt water. These considerations and the fact that mollusks excrete considerable quantities of gelatinous matters lead me to the conclusion expressed above, that the escape of fats and carbohydrates must be due largely if not entirely to processes independent of osmose. Of course, small quantities of fats and carbohydrates must have been consumed in the ordinary process of metabolism, but it is hard to believe that this could explain any considerable part of the loss observed.

EFFECT OF FLOATING UPON THE COMPOSITION OF THE TOTAL SHELL CONTENTS OF THE OYSTERS.

To compare the nutritive values of the oysters before and after floating, the liquid as well as the solid portion of the shell contents must be taken into account. The foregoing statements of changes in composition in floating apply mainly to the flesh. The data suffice for only an approximate estimate of the changes in the liquids. The difficulty in the computation is the lack of exact information as to how much of the liquid portion escaped in the floating. The oystermen say that the animals sometimes open their valves considerably while they are on the floats. This would of course give the water some opportunity to wash away the liquid contents of the shells, but the figures here given seem to me to imply that the quantity thus removed can not be very great.

An attempt to compute the changes in the composition of the total shell contents might be made by assuming the weight of the shells to be unaltered in the floating.

Table 42 may be worth inserting here, though I do not regard it as accurate, since the shells would be apt to lose weight by the washing off of adhering matters and otherwise in the handling and floating. In each case the protein seems to be slightly increased by the floating, but it is evident that we shall have to assume only a very small loss of weight of the shells to make the figures for the protein the same after as before floating. This would give, in each case, a very small loss of fats and extractives, a considerable loss of mineral matters, and a large gain of water, which is exactly what would be expected. These computa-

tions, therefore, tend to confirm the correctness of those of Table 41, in which the absolute weight of the protein of the flesh was assumed to be unaltered.

TABLE 42.—*Estimated changes in composition of whole specimens of oysters in floating.*

[Estimates based upon analyses and assumption that the weight of the shells is unchanged in floating.]

Constituents of specimens.	James River. Not floated.	James River. Floated.	Potomac River. Not floated.	Potomac River. Floated.
	100 parts by weight of specimens in natural condition contained (per analysis)—	The same specimen after dialysis is estimated to contain—	100 parts by weight of specimens in natural condition contained (per analysis)—	The same specimen after dialysis is estimated to contain—
Shell contents:	*Parts by weight.*	*Parts by weight.*	*Parts by weight.*	*Parts by weight.*
Flesh	9.49	11.68	8.35	10.22
Liquids	5.51	5.90	7.78	6.50
Refuse:				
Shells	84.36	84.36	83.25	83.25
Loss, etc	0.64	0.50	0.62	0.37
Total	100.00	102.44	100.00	100.34
In shell contents:				
In water-free substance:				
Protein	1.12	1.15	1.00	1.06
Fat	0.25	0.22	0.20	0.20
Carbohydrates, etc	0.66	0.66	0.67	0.62
Mineral matters	0.35	0.26	0.37	0.24
Total water-free substance	2.38	2.29	2.24	2.12
Water	12.62	15.29	13.89	14.60
Total shell contents	15.00	17.58	16.13	16.72

The practice of floating oysters before putting them on the market is very general, and I am told that many retail dealers also add water to the oysters before delivering them to their customers, finding that their bulk and plumpness are thereby increased. A more detailed experimental study of the changes which take place in these operations would be of no little practical value. Meanwhile it is safe to say that in the floating the oysters take up water and lose small quantities of their fats and carbohydrates and a large proportion of their mineral salts. To compensate for this loss of nutritive material, there is, generally speaking, an improvement in the flavor. That is to say, the oysters as taken from the salt water, are rather salt to the taste, and many people prefer the flavor after they have been freshened in the floating. The removal of part of the salts also appears to improve the keeping quality of the oysters.

5. EUROPEAN ANALYSES OF MOLLUSKS AND CRUSTACEANS.

The following table, translated from König (König, Nahrungsmittel, I Band, S. 219), contains all the detailed analyses of European mollusks and crustaceans which have come to my notice in forms desirable for quotation here:

TABLE 43.—*European analyses of mollusks and crustaceans, from König.*

Specimens.	In flesh.					In water-free substance.			Analyst.
	Water.	Protein (nitrogen × 6.25).	Fat.	Carbohydrates, etc.	Ash.	Protein.	Fat.	Nitrogen.	
Oyster (Ostrea edulis):									
Flesh	80.38	13.31	1.51	4.80		67.83	7.70	10.85	Payen.*
Liquids	95.75	.54	......	3.72		12.71	......	2.03	Payen.*
Shell contents	89.69	4.95	.37	2.62	2.37	48.01	3.59	7.68	König.† Krauch.
Flesh (Ostend)	82.03	8.25	1.77	6.16	1.79	45.91	9.84	7.34	Stutzer.‡
Mussel (Mytilus edulis):									
Cooked flesh	75.74	15.62	2.42	6.22		64.39	9.98	10.30	Payen.*
Clam (Mactra solida)	70.76	15.56	1.90	11.78		53.22	6.50	8.52	Payen.*
Snail (Helix):									
Cooked flesh	76.17	15.62	.95	7.26		65.55	3.99	14.88	Payen.*
Lobster (Homarus vulgaris):									
Uncooked flesh	76.61	18.31	1.17	3.91		78.28	5.00	12.52	Payen.*
"Inner, white mass"	84.31	11.69	1.44	2.56		74.51	9.18	11.92	Payen.*
Eggs	62.98	21.06	8.23	7.73		56.89	22.23	9.10	Payen.*
Flesh preserved in salt water	77.49	19.09	.97	.50	1.95	84.81	4.31	13.57	König.†
River crawfish (Astacus fluviatilis):									
Salted flesh	72.74	13.63	.36	.21	13.06	50.00	1.32	8.00	König.†

*Substances Alimentaire, Paris, 1865, p. 488.
†Original contribution.
‡Repertorium of Analyt. Chem., 1882, S. 161.

PART II.

NUTRITIVE VALUES OF FOOD-FISHES, MOLLUSKS, AND CRUSTACEANS.

1. INTRODUCTION; EXPLANATIONS.

For those who are not familiar with the newer teachings of chemistry and physiology and their application in judging of the nutritive values of the fishes and invertebrates of which analyses are given in detail in Part I and recapitulated in the pages beyond, a few words of explanation of some of the later results of experimental inquiry regarding foods and their uses in nutrition may not be entirely out of place here. The statements which follow are in part condensed from articles by the writer in the Report of the Oyster Investigation and Shellfish Commission of New York, for 1887, by E. G. Blackford, commissioner, and in the National Medical Dictionary, edited by Dr. J. S. Billings, U. S. A.

If the reader will take the pains to notice the next piece of beef that he has to carve for dinner, he will, of course, notice first of all that, along with the meat which is good to eat, there is more or less bone, which, except in so far as it may be used for soup, is of no value for food. The beef, then, may be regarded as consisting of edible portion and refuse. The same is true of fish. In eggs there is a corresponding distinction between shells and the so-called "meat," and oysters and other shellfish in like manner include the shells, which are simply refuse, and the shell contents which make up the edible portion. The inside of the potato and the wheat flour are the edible portion, and the skin and bran are refuse of potatoes and wheat.

If we take the beef and separate the meat from the bone, cut it into fine particles and keep it for a long time in a hot oven it will be gradually dried, that is to say the water will be driven out of it and the so-called nutritive substance will remain. In the same way the flesh of fish, oysters, milk, eggs, potatoes, and flour are found to consist of water and nutritive material. In estimating the values of these different materials for food we leave the refuse and the water out of account and consider only the nutritive ingredients.

We may take a piece of beef, and after cutting out the bone and drying the meat put the latter in the fire and burn it. Nearly all will be consumed, but a portion will remain as ashes. An operation of this sort is

regularly carried on in the chemical laboratory in the analysis of meat and other food materials. Portions are dried with proper apparatus, and the percentages of water and water-free substances are determined; other portions are burned, and the percentages of ash are found out. If we weigh the whole meat, bone and all, to start with, and afterwards weigh bone and other refuse and the meat, we can easily calculate the percentages of refuse and edible portion. If we then determine the percentages of water, water-free substance, and ash in the meat, we have made a fair start in the analysis for determining the food value. The water-free substance contains all of the nutritive materials, or nutrients, but the analysis thus far has told only the percentage of ash, or mineral matters. The proportions of the other ingredients must be found out before we can judge exactly of the food value.

The meat consists of lean and fat. Part of the fat is in large lumps, which can be easily separated from the lean. Indeed we often cut out the fat of the meat which is served on our plates at the table, and reject it instead of eating it. But a portion of the fat is in very fine particles diffused throughout the lean. Much of this finely divided fat is in particles so small as to be invisible to the naked eye, but it is possible to separate them very completely from the lean by processes of analysis common in the laboratory. After the water and the fat have been removed from the lean meat the material which remains will contain a little mineral matter, which would be left as ash if it were burned; the rest consists of so-called protein compounds. The protein is the chief nutritive constituent of fish and eggs, as well as of lean meat. It occurs also in milk and in vegetable foods, such as wheat, corn, potatoes, etc.

Fat is familiar to us in meat, from which we get it in the form of tallow and lard; in milk, from which it is obtained as butter; in the various oils, such as olive oil, cotton-seed oil, and the oils of wheat and corn. Larger or smaller proportions of fat are found in most food materials.

Potatoes, wheat, and corn contain large proportions of starch. Sugar cane and sorghum are rich in sugar. Starch and sugar are very similar in chemical composition, and are called carbohydrates. Other carbohydrates are found in animals and plants; such as inosite, or "muscle sugar," in muscle; and glycogen, or "liver sugar," in the liver.

The mineral matter, or ash, which is left behind when animal or vegetable matter is burned, consists of a variety of chemical compounds commonly called salts, and including phosphates, sulphates, and chlorides of the metals calcium, magnesium, potassium, and sodium. Calcium phosphate, or phosphate of lime, is the chief mineral constituent of bone. Common salt is chloride of sodium.

The number of the different chemical compounds in our animal and vegetable food materials is very large, but leaving water out of account, it is customary to divide the rest into the classes of which we have spoken, to wit, protein, fats, carbohydrates, and mineral matters, and to look upon these as the nutritive ingredients, or nutrients

of food. The proportions of these ingredients are determined by the somewhat complicated methods of chemical analysis followed in the laboratory, but our everyday handling of food materials often involves processes, though crude ones, of analysis.

We let milk stand; the globules of fat rise in cream, still mingled, however, with water, protein, carbohydrates, and mineral salts. To separate the other ingredients from the fat the cream is churned. The more perfect this separation—*i. e.*, the more accurate the analysis—the more wholesome will be the butter. Put a little rennet in the skimmed milk, and the casein, called in chemical language an albuminoid or protein compound, will be curdled, and may be freed from the bulk of the water, sugar, and other ingredients by the cheese press, as is done in making cheese. To separate milk-sugar, a carbohydrate, from the whey is a simple matter. One may see it done by the Swiss shepherds in their Alpine huts. But farmers find it more profitable to put it in the pig-pen, the occupants of which are endowed with the happy faculty of transforming sugar, starch, and other carbohydrates of their food into the fat of pork.

The New England boy who on cold winter mornings goes to the barn to feed the cattle and solaces himself by taking grain from the wheat bin and chewing it into what he calls "wheat gum" makes, unknowingly, a rough sort of analysis of the wheat. With the crushing of the grain and the action of the saliva in his mouth the starch, sugar, and other carbohydrates are separated. Some of the fat—*i. e.*, oil—is also removed, and finds its way with the carbohydrates into the stomach. The tenacious gluten, which contains the albuminoids or protein and constitutes what he calls gum, is left. When, in the natural order of events, the cows are cared for and the gum is swallowed, its albuminoids enter upon a round of transformation in the boy's body, in the course of which they are changed to other forms of protein, such as albumen of blood or myosin of muscle, or are converted into fat, or are consumed with the oil and sugar and starch to yield heat to keep his body warm and give him muscular strength for his work or play.

There is, unfortunately, a little confusion of terms in the usages of different writers on these subjects. Thus the words protein, proteids, and albuminoids are all applied to what we have here called the protein compounds. The term albuminoid, albumen-like, comes from albumen, which is best known in the form of white of eggs, a typical albuminoid compound. The term proteids is applied by some writers to albuminoids and by others to very different classes of materials. The fats are sometimes spoken of as hydrocarbons, but this use of the latter term is very incorrect.

These different classes of nutrients in food, to wit, protein, fats, carbohydrates, and mineral matters have different uses in nutrition. Muscle, tendon, and bone are formed from the protein compounds. These are sometimes called flesh-formers, because they make flesh. Their chief use

in the body is to make blood, and to build up the muscle, tendon, bone, and other tissues which constitute the framework of the body and repair them, as they are being continually worn out by use. Brain and nerve are also formed to a considerable extent from the protein compounds of the food. The protein of the food is also formed into fat in the body, and serves as fuel to supply it with heat and muscle energy. The fats of the food are stored as fat in the body, and may be transformed into carbohydrates, but their chief use is for fuel. The carbohydrates are transformed into fat in the body, and may be stored as body fat, but their chief use is for fuel. The mineral matters make bone and have various other uses in the body.

When we eat meat, its protein serves to make blood, bone, muscle, tendon, brain, and nerve. We can also use it to make fat, and it is consumed—*i. e.*, burned as fuel to yield its heat to keep our bodies warm and give muscular strength for work. The fat of the meat can not do the work of the protein in forming muscle, tendon, and the like, but is much more valuable than protein for fuel. Bread supplies us with protein and fat, and also with carbohydrates in the form of starch, dextrin, and sugar. The protein and fats serve the same purposes as those of meat. The carbohydrates which make up the bulk of the nutritive material of bread and potatoes, and of which only minutest quantities occur in meat, are valuable chiefly as fuel, though they also yield fat.

To recapitulate: The nutritive material of very lean meat and the leaner kinds of fish consists almost entirely of protein. Tallow, lard, oils, and butter are fats. Sugar and starch are carbohydrates. All the different food materials contain mineral matters. Animal foods supply chiefly protein and fats. Most vegetable foods contain but little of these, their nutrients being chiefly carbohydrates. Beans, pease, and other leguminous plants, however, supply considerable quantities of protein. Milk differs from most other animal foods in that it has large quantities of a carbohydrate, "milk-sugar." Oysters approach milk in composition.

For nourishment we need all of the different classes of nutrients and in proper proportions. Thus a day's food for an average man doing moderately hard muscular work may appropriately supply, on the average, about 4½ ounces of protein, the same quantity of fats, and 16 ounces of carbohydrates.

The cheapest food is that which supplies the most nutritive material for the least money; the most economical food is that which is cheapest and best adapted to the wants of the user.

From the standpoint of their uses in the nutrition of man, the constituents of ordinary foods may be succinctly classified as follows:

Edible substance, as the flesh of meats and fish, the shell contents of oysters, wheat flour.

Refuse, as bones of meat and fish, the shells of oysters, bran of wheat.

The edible substance consists of (1) water, (2) nutritive substance or nutrients.

The water, refuse, and the salt of salted meat and fish are called non-nutrients. The water contained in foods and beverages has the same composition and properties as other water; it is, of course, indispensable for nourishment, but it is not a nutrient in the sense in which it is here used. In comparing the values of different food materials for nourishment, the refuse and water are left out of account.

PRINCIPAL NUTRIENTS OF FOOD.

Protein:
- Albuminoids: e. g., albumen of egg, myosin of muscle (lean of meat), casein of milk, gluten of wheat.
- Gelatinoids: e. g., ossein of bone, collagen of tendons (which yielded gelatin).

Fats: e. g., fats of meat, butter, olive oil, oil of maize and wheat.

Carbohydrates: e. g., starch, sugar, cellulose (woody fiber).

Mineral matters or ash: e. g., calcium, potassium, and sodium, phosphates and chlorides.

WAYS IN WHICH THE NUTRIENTS ARE USED IN THE BODY.

The protein of food
- forms the (nitrogenous) basis of blood, muscle, connective tissue, etc.,
- is transformed into fats and carbohydrates,
- is consumed for fuel.

The fats of food
- are stored as fat,
- are consumed for fuel.

The carbohydrates of food
- are transformed into fat,
- are consumed for fuel.

POTENTIAL ENERGY OF FOOD.

In being consumed for fuel, the nutrients yield energy in the forms of heat, which keeps the body warm, and muscular energy, strength for work. The quantities of energy which different food materials are capable of yielding are determined by experiments with the respirative apparatus and the calorimeter. In their use as fuel in the body the nutrients appear to replace one another in proportion to their potential energy as indicated by their heats of combustion. This energy, which is accordingly taken as the measure of their fuel value, is estimated in

calories. The calorie is the heat which would raise a kilogramme of water 1° C. (or 1 pound of water about 4° Fahr.). A foot-ton is the energy (power) which would lift 1 ton 1 foot. One calorie corresponds to 1.53 foot-tons. A gramme of protein or a gramme of carbohydrates is assumed to yield 4.1, and a gramme of fats 9.3 calories. A given weight of fats is thus taken to be equivalent, in fuel value, on the average, to a little over twice the same weight of protein or carbohydrates. The figures for potential energy in Table I are calculated for each food material by multiplying the number of grammes of protein and of carbohydrates in 1 pound (1 pound equals 453.6 grammes) by 4.1, and the number of grammes of fat by 9.3, and taking the sum of these three products as the number of calories of potential energy in a pound of the material.*

I have not applied these methods of calculation to shellfish in this article, because the nature of the compounds which make up their nutritive ingredients is not fully understood, and it is not certain that what we call protein, fats, and carbohydrates in them have the same fuel value as in meats, fish, etc. For the same reason I have not attempted detailed estimates of the pecuniary economy of shellfish as compared with other food materials.†

The result of analyses of food material can be stated in a variety of ways. That followed in Tables I and III, beyond, may be explained by an example.

The flesh or edible portion of a specimen of beef sirloin, of medium fatness, was analyzed and found to contain, approximately—water, 60 per cent.; protein, 19 per cent.; fats, 20 per cent.; mineral matters, 1 per cent. These, then, are the percentages of water and nutrients in the edible portion of the meat. But when we buy our sirloin steak or roast by the pound, as we ordinarily do, we get not only the flesh, the edible substance, but with it more or less bone, sinew, and other refuse matter. This specimen contained about one-fourth, or 25 per cent., of bone, and three-fourths, or 75 per cent., of flesh. If, then, we are to consider the composition of the meat as we buy it, we must take the refuse matters into account. The proportions of the several ingredients in both the edible portion and the whole piece above referred to may be stated thus:

Constituents.	In flesh, edible portion.	In meat as bought, including refuse.
	Per cent.	*Per cent.*
Refuse, bones, etc	None.	25
Water	60	45
Protein	19	$14\frac{1}{4}$
Fat	20	15
Mineral matters	1	$0\frac{3}{4}$
Total	100	100

* See "The Potential Energy of Food," in the Century Magazine for July, 1887.

† See article on "Pecuniary Economy of Food," in the Century Magazine for January, 1888.

This very imperfect analysis may be stated in the following form, as is done in the tables beyond:‡

Constituents of sample of beef, sirloin (medium fatness).

	Per cent.
In edible portion, *i. e.*, flesh freed from bone and other refuse:	
Water	60
Protein	19
Fats	20
Mineral matters	1
In meat as purchased (including both edible portion and refuse):	
Refuse, bones, etc	25
Edible portion:	
Water	45
Protein	14.3
Fats	15
Mineral matters	0.7

Table I, herewith, gives the composition of a number of animal foods, mostly from analyses undertaken in connection with the investigation described in Part I of this monograph, as stated in the introduction. It is only a short time since analyses of American meats, fish, etc., have been undertaken in any considerable number, and those as yet accomplished are far from sufficient for a complete survey of the subject. Indeed, the work already done can be regarded only as a beginning. Still, the figures will give a tolerably fair idea of the average composition of the articles named:

TABLE I.—*Percentages of nutrients (nutritive ingredients), water, etc., and estimated potential energy (fuel value) in specimens of food materials.*

Food materials.	Refuse: bones, skin, shells, etc.	Edible portion. Water.	Nutrients. Total.	Protein.	Fats.	Carbo-hydrates.	Mineral matters.	Potential energy in one pound of each material.
Animal foods as purchased, including edible portion and refuse:	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Beef, side*	19.7	44.0	36.3	13.8	21.7	....	0.8	1,170
Beef, round*	10.0	60.0	30.0	20.7	8.1	....	1.2	725
Beef, neck*	19.9	49.6	30.5	15.4	14.3	....	0.8	890
Beef, sirloin*	25.0	45.0	30.0	15.0	14.3	....	0.7	885
Beef, flank*	11.7	24.2	64.1	10.6	52.9	....	0.6	2,430
Mutton, side*	20.0	42.9	37.1	13.2	23.2	....	0.7	1,225
Mutton, leg*	18.4	50.4	31.2	15.0	15.5	....	0.7	935
Mutton, shoulder*	16.8	48.7	34.5	15.0	18.7	....	0.8	1,070
Mutton, loin (chops)*	16.3	41.3	42.4	12.5	29.3	....	0.6	1,470
Smoked ham	14.0	36.3	49.7	14.6	34.2	....	0.9	1,715
Pork, very fat	10.4	9.5	80.1	2.8	76.5	....	0.8	3,280
Chicken †	41.6	42.2	16.2	14.2	1.2	....	0.8	315
Turkey	35.4	42.8	21.8	15.4	5.6	....	0.8	525
Flounder, whole	66.8	27.2	6.0	5.2	0.3	....	0.5	110
Haddock, dressed	51.0	40.0	9.0	8.2	0.2	....	0.6	160
Bluefish, dressed	48.6	40.3	11.1	9.8	0.6	....	0.7	210
Brook trout, whole	48.1	40.4	11.5	9.8	1.1	....	0.6	230
Codfish, dressed	29.9	58.5	11.6	10.6	0.2	....	0.8	205
Whitefish, whole	53.5	32.5	14.0	10.3	3.0	....	0.7	320
Shad, whole	50.1	35.2	14.7	9.2	4.8	....	0.7	375
Turbot, whole	47.7	37.3	15.0	6.8	7.5	....	0.7	445

* From well-fattened animals. † Rather lean.

‡ The tables contain also columns for carbohydrates, etc., which occur in milk and in some shellfish, but are not found in ordinary meats in sufficient amount to warrant their presence in such tables as these.

TABLE I.—*Percentages of nutrients (nutritive ingredients), water, etc., and estimated potential energy (fuel value) in specimens of food materials*—Continued.

Food materials.	Refuse: bones, skin, shells, etc.	Edible portion.						
		Water.	Nutrients.					Potential energy in one pound of each material.
			Total.	Protein.	Fats.	Carbohydrates.	Mineral matters.	
Animal foods as purchased, including edible portion and refuse:	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Mackerel, fat, whole	33.8	42.4	23.8	12.1	10.7	....	1.0	675
Mackerel, lean, whole	38.3	48.5	13.2	11.2	1.4	....	0.6	265
Mackerel, average, whole	44.6	40.4	15.0	10.0	4.3	....	0.7	365
Halibut, dressed	17.7	61.9	20.4	15.1	4.4	....	0.9	465
Salmon, whole	35.3	40.6	24.1	14.3	8.8	....	1.0	635
Eel	36.0	33.8	30.2	8.6	21.0	....	0.6	1,045
Salt codfish	42.1	40.3	17.6	16.0	0.4	....	1.2	315
Smoked herring	50.9	19.2	29.9	20.2	8.8	....	0.9	745
Salt mackerel	40.4	28.1	31.5	14.7	15.1	....	1.7	910
Canned salmon	4.9	59.3	35.8	19.3	15.3	....	1.2	1,005
Canned sardines	5.0	53.6	41.4	24.0	12.1	....	5.3	955
Lobsters	62.1	31.0	6.9	5.5	0.7	0.1	0.6	135
Oysters in shell	82.3	15.4	2.3	1.1	0.2	0.6	0.4	40
Hens' eggs	13.7	63.1	23.2	11.8	10.2	0.4	0.8	655
Animal foods, edible portion:								
Beef, side*	....	54.7	45.3	17.2	27.1	....	1.0	1,465
Beef, round*	....	66.7	33.3	23.0	9.0	....	1.3	805
Beef, sirloin*	....	60.0	40.0	20.0	19.0	....	1.0	1,175
Mutton, side*	....	45.9	54.1	14.7	38.7	....	0.7	1,905
Mutton, leg*	....	61.8	38.2	18.3	19.0	....	0.9	1,140
Mutton, loin (chops)*	....	49.3	50.7	15.0	35.0	....	0.7	1,755
Flounder	....	84.2	15.8	13.8	0.7	....	1.3	285
Codfish	....	82.6	17.4	15.8	0.4	....	1.2	310
Mackerel, fat	....	64.0	36.0	18.2	16.3	....	1.5	1,025
Mackerel, lean	....	78.7	21.3	18.1	2.2	....	1.0	430
Mackerel, average	....	71.6	28.4	18.8	8.2	....	1.4	695
Salmon	....	63.6	36.4	21.6	13.4	....	1.4	965
Oysters, fat	....	81.7	18.3	8.0	1.7	6.7	1.9	345
Oysters, lean	....	90.9	9.1	4.2	0.6	1.8	2.5	135
Oysters, average	....	87.1	12.9	6.0	1.2	3.7	2.0	230
Hens' eggs	....	73.1	26.9	13.7	11.7	0.5	1.0	760
Cows' milk	....	87.4	12.6	3.4	3.7	4.8	0.7	310
Do	....	90.7	9.3	3.1	0.7	4.8	0.7	175
Cheese, whole milk	....	31.2	68.8	27.1	35.5	2.3	3.9	2,045
Cheese, skimmed milk	....	41.3	58.7	38.4	6.8	8.9	4.6	1,165
Butter	....	10.0	90.0	1.0	85.0	0.5	3.5	3,615
Oleomargarine	....	10.0	90.0	0.6	84.5	0.4	4.5	3,585
Lard	....	1.0	99.0	....	99.0	....	....	4,180
Vegetable foods:								
Wheat bread	....	32.7	67.3	8.9	1.9	55.5	1.0	1,280
Wheat flour	....	11.6	88.4	11.1	1.1	75.6	0.6	1,660
Graham flour	....	13.0	87.0	11.7	1.7	71.8	1.8	1,625
Rye flour	....	13.1	86.9	6.7	6.7	78.7	0.7	1,620
Buckwheat flour	....	13.5	86.5	6.5	1.3	77.6	1.1	1,620
Beans	....	13.7	86.3	23.2	2.1	57.4	3.6	1,585
Oatmeal	....	7.7	92.3	15.1	7.1	68.1	2.0	1,845
Corn (maize) meal	....	14.5	85.5	9.1	3.8	71.0	1.6	1,650
Rice	....	12.4	87.6	7.4	0.4	79.4	0.4	1,630
Sugar	....	2.2	97.8	0.3	....	96.7	0.8	1,800
Potatoes†	10.0	68.0	22.0	1.8	0.2	19.1	0.9	395
Potatoes	....	75.5	24.5	2.0	0.2	21.3	1.0	440
Sweet potatoes	....	75.8	24.2	1.5	0.4	21.1	1.2	435
Turnips	....	91.2	8.8	1.0	0.2	6.9	0.7	155
Carrots	....	87.9	12.1	1.0	0.2	10.1	0.8	215
Cabbage	....	90.0	10.0	1.9	0.2	6.2	1.2	170
Melons	....	95.2	4.8	1.1	0.6	2.5	0.6	90
Apples	....	84.8	15.2	0.4	....	14.3	0.5	275
Pears	....	83.0	17.0	0.4	....	16.3	0.3	310
Bananas	....	73.1	26.9	1.9	0.6	23.3	1.1	495
Beverages:					Alcohol.			
Lager beer	....	90.3	....	0.4	2.0	5.8	0.2	....
Porter and ale	....	88.1	....	0.6	5.1	6.8	0.4	....
Rhine wine, white	....	86.3	....	....	9.3	2.3	0.2	....
Rhine wine, red	....	86.9	....	....	8.1	3.0	0.3	....
French wine, claret	....	88.3	....	....	8.0	2.3	0.2	....
Sherry wine	....	79.5	....	....	17.0	3.2	0.3	....

* From well-fattened animals.

† As purchased, including refuse, skin, etc.

DIGESTIBILITY OF FOODS.

Table II epitomizes the results of some sixty experiments, mostly with men but a few with children, in which the proportions of the ingredients of food materials actually digested have been found by comparison of amounts and composition of the food eaten with those of the undigested excreta. Table III is computed by applying the data obtained by these experiments to some of those for the composition of food materials in Table I.

TABLE II.—*Digestibility of nutrients of food materials.*

Food materials.	Of the total amounts of protein, fats, and carbohydrates, the following percentages were digested:		
	Protein.	Fats.	Carbohydrates.
Meats and fish	Practically all.	79 to 92	....
Eggs	....do	96	....
Milk	88 to 100	93 to 98	?
Butter	....	98	....
Oleomargarine	....	96	....
Wheat bread	81 to 100	?	99
Corn (maize) meal	89	?	97
Rice	84	?	99
Pease	86	?	96
Potatoes	74	?	92
Beets	72	?	82

TABLE III.—*Proportions of nutrients digested and not digested from food materials by healthy men.*

Food materials.	Protein.			Fats.			Carbohydrates.			Mineral matters.	Water.
	Digestible.	Undigestible.	Total.	Digestible.	Undigestible.	Total.	Digestible.	Undigestible.	Total.		
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Beef, round	23.0	0.0	23.0	8.1	0.9	9.0	0.0	0.0	0.0	1.3	66.7
Beef, sirloin	20.0	0.0	20.0	17.1	1.9	19.0	0.0	0.0	0.0	1.0	60.0
Pork, very fat	3.0	0.0	3.0	74.5	6.0	80.5	......	......	......	6.5	10.0
Haddock	17.1	0.0	17.1	0.3	......	0.3	0.0	0.0	0.0	1.2	81.4
Mackerel	18.8	0.0	18.8	7.4	0.8	8.2	0.0	0.0	0.0	1.4	71.6
Hens' eggs	13.4	0.0	13.4	9.4	2.4	11.8	0.7	0.0	0.7	1.0	73.1
Cows' milk	3.4	0.0	3.4	3.6	0.1	3.7	4.8	0.0	4.8	0.7	87.4
Cheese, whole milk	27.1	0.0	27.1	34.6	0.9	35.5	2.3	0.0	2.3	3.9	31.2
Butter	1.0	......	1.0	85.8	1.7	87.5	0.5	......	0.5	2.0	9.0
Oleomargarine	0.4	......	0.4	83.9	3.3	87.2	0.0	......	0.0	2.1	10.3
Sugar	0.3	......	0.3	......	......	......	96.7	0.0	96.7	0.8	2.2
Wheat flour, very fine	7.6	1.3	8.9	1.0	......	1.0	74.4	0.8	75.2	0.3	14.6
Wheat flour, medium	9.5	2.1	11.6	0.8	......	0.8	70.4	1.8	72.2	0.4	15.0
Wheat flour coarse, whole wheat	8.2	2.7	10.9	1.8	......	1.8	66.4	5.3	71.7	1.2	14.4
Wheat bread, average	7.7	1.2	8.9	1.9	......	1.9	54.9	0.6	55.5	1.0	32.7
Black bread	4.5	1.6	6.1	......	......	......	43.3	5.3	48.6	1.5	43.8
Pease	19.7	3.2	22.9	1.8	......	1.8	55.7	2.1	57.8	2.5	15.0
Corn (maize) meal	7.9	1.2	9.1	3.8	......	3.8	68.7	2.3	71.0	1.6	14.5
Rice	6.2	1.2	7.4	0.4	......	0.4	78.7	0.7	79.4	0.4	12.4
Potatoes	1.5	0.5	2.0	0.2	......	0.2	19.7	1.6	21.3	1.0	75.5
Turnips	0.7	0.3	1.0	0.2	......	0.2	5.6	1.3	6.9	0.7	91.2

STANDARDS FOR DAILY DIETARIES FOR PEOPLE OF DIFFERENT CLASSES.

The demands of different people for nutrients in the daily food vary with age, sex, occupation, and other conditions, including especially the widely differing characteristics of individuals. The standards in Table IV, herewith, are intended to represent roughly the needs of average individuals of the classes named. Nos. 1, 3, 4, 5, and 6, are as proposed by Voit and his followers of the Munich school of physiologists, and are based upon observations of quantities actually consumed in a considerable number of cases. Nos. 7 and 8 are by Voit, and based both upon quantities consumed by individuals under experiment and upon observed dietaries of a much larger number of persons in Germany. Nos. 9, 10, and 11 are by Playfair, and are based mainly upon observations of actual dietaries in England. No. 2 is calculated by the writer from the data and results used in Nos. 1 and 3. In Nos. 12, 13, 14, and 15, by the writer, the data of Voit, Playfair, and other European observers are taken into account, but the conclusions are modified by the results of studies of a considerable number of dietaries of people in the United States.

TABLE IV.—*Standards for daily dietaries for people of different classes.*

Classes.	Nutrients.				Potential energy.
	Protein.	Fats.	Carbohydrates.	Total.	
	*Grms.**	*Grms.*	*Grms.*	*Grms.*	*Calories.*
1. Children to 1½ years	28 (20 to 36)	37 (30 to 45)	75 (60 to 90)	140	765
2. Children 2 to 6 years	55 (36 to 70)	40 (35 to 48)	200 (100 to 250)	295	1,420
3. Children 6 to 15 years	75 (70 to 80)	43 (37 to 50)	325 (250 to 400)	443	2,040
4. Aged woman	80	50	260	390	1,860
5. Aged man	100	68	350	518	2,475
6. Woman at moderate work, German	92	44	400	536	2,425
7. Man at moderate work, German	118	156	500	674	3,055
8. Man at hard work, German	145	100	450	695	3,370
9. Man with moderate exercise, English	119	51	531	701	3,140
10. Active laborer, English	156	71	568	795	3,630
11. Hard-worked laborer, English	185	71	568	824	3,750
12. Woman with light exercise, American	80	80	300	460	2,300
13. Man with light exercise (or woman with moderate work), American	100	100	360	560	2,815
14. Man at moderate work, American	125	125	450	700	3,520
15. Man at hard work, American	150	150	500	800	4,060

* One pound avoirdupois = 453.6 grammes; 1 ounce = 28.3 grammes.

ACTUAL DIETARIES OF DIFFERENT CLASSES OF PEOPLE.

Table V gives the quantities of nutrients and potential energy in a number of observed dietaries. The figures for European dietaries are mostly by Voit and his followers in Germany, and by Playfair in England. The American figures are by the writer; those for the Army and Navy rations are based upon the United States regulations, the rest upon observation of actual dietaries.

TABLE V.—*Nutrients and potential energy in dietaries of different people.*

Classes.	Nutrients. Protein.	Fats.	Carbo-hydrates.	Total.	Potential energy of nutrients.
European and Japanese dietaries.	*Grms.*	*Grms.*	*Grms.*	*Grms.*	*Calories.*
1. Sewing girl, London, wages 93 cents (3*s.* 9*d*) per week	53	33	316	402	1,820
2. Factory girl, Leipsic, Germany, wages $1.21 per week	52	53	301	406	1,940
3. Weaver, England, time of scarcity	60	28	398	486	2,138
4. Laborers, Lombardy, Italy; diet mostly vegetable	82	40	362	484	2,192
5. Trappist monk in cloister; very little exercise, vegetable diet	68	11	469	548	2,304
6. Students, Japan	97	16	438	551	2,343
7. University professor, Munich, Germany; very little exercise	100	100	240	440	2,324
8. Lawyer, Munich	80	125	222	427	2,401
9. Physician, Munich	131	95	327	553	2,762
10. Painter, Leipsic, Germany	87	69	366	522	2,500
11. Cabinet-maker, Leipsic, Germany	77	57	466	600	2,757
12. "Fully-fed" tailors, England	131	39	525	695	3,053
13. "Well paid" mechanic, Munich, Germany	151	54	479	684	3,085
14. Carpenter, Munich, Germany	131	68	494	693	3,194
15. "Hard-worked" weaver, England	151	43	622	816	3,569
16. Blacksmith, England	176	71	667	914	4,117
17. Miners at very severe work, Germany	133	113	634	880	4,195
18. Brick-makers (Italians at contract work), Munich	167	117	675	959	4,641
19. Brewery laborer, Munich; very severe work, exceptional diet	223	113	909	1,245	5,692
20. German soldiers, peace footing	114	39	480	633	2,798
21. German soldiers, war footing	134	58	489	681	3,093
22. German soldiers, Franco-German war; extraordinary ration	157	285	331	773	4,652
United States and Canadian dietaries.					
23. French Canadians, working people, in Canada	109	109	527	745	3,622
24. French Canadians, factory operatives, mechanics, etc., in Massachusetts	118	204	549	871	4,632
25. Other factory operatives, mechanics, etc., Massachusetts	127	186	531	844	4,428
26. Glass-blowers, East Cambridge, Mass	95	132	481	708	3,590
27. Factory operatives, dressmakers, clerks, etc., boarding-house	114	150	522	786	4,002
28*a*. Well-to-do private family, Connecticut — food purchased	129	183	467	779	4,146
28*b*. Well-to-do private family, Connecticut — food eaten	128	177	466	771	4,082
29*a*. College students from Northern and Eastern States; boarding club, two dietaries of the same club — food purchased	161	204	680	1,045	5,345
29*b*. Same — food eaten	138	184	622	944	4,827
30*a*. Same — food purchased	115	163	460	738	3,874
30*b*. Same — food eaten	104	136	421	661	3,417
31. College football team, food eaten	181	292	557	1,030	5,742
32. Machinist, Boston, Mass	182	254	617	1,053	5,638
33. Brick-makers, Middletown, Conn	222	263	758	1,243	6,464
34. Teamsters, marble-workers, etc., with hard work; Boston, Mass	254	363	826	1,443	7,804
35. Brick-makers, Cambridge, Mass	180	365	1,150	1,695	8,848
36. U. S. Army ration	120	161	454	735	3,851
37. U. S. Navy ration	143	184	520	847	4,998

2. DIGESTIBILITY OF FISH.

In the explanations in the previous chapter the digestibility of food materials was touched upon and statistics of results of experiments were cited. Those for the digestibility of fish were based upon experiments made in connection with the investigations here reported. These experiments have already been described in detail,* and only the main results need be recapitulated here. In connection with them the results of other investigations may be cited.

* Zeitschrift fur Biologie, 24, 1888, p. 16.

There are two ways of studying experimentally the digestibility of foods. One is by experiments in artificial digestion, in which the food material is exposed to the action of the digestive juices in the laboratory, in apparatus fitted for the purpose. The other is by direct experiments with man or other animals.

A series of experiments upon the artificial digestion of fish in gastric juice has been made by Messrs. Chittenden and Cummins, and described in the report of the U. S. Commissioner of Fish and Fisheries for 1884, p. 1109.

In the introduction to the account of their work, they speak of these experiments as follows:

Few experiments appear to have been made on the digestibility of fish; this is the more strange when we consider what an important item of food fish constitutes, particularly along our seaboard. * * * As Voit remarks, "nothing certain is known regarding the digestibility of different kinds of fish, although much is said concerning it. Probably digestibility is in part dependent upon the nature of the fat present and the manner of its distribution; thus the presence of a difficultly fusible fat with considerable stearin would tend to hinder digestibility (as in mutton); the same thing probably occurs when the contents of the sarcolemma are permeated with much fat (as in the lobster and eel)." This statement at once suggests the probability of great variation in the digestibility of the flesh of any one species, dependent upon a large number of conditions, which, in the case of fish particularly, are somewhat difficult of control; thus age, sex, food, period of spawning, and length of time they have been preserved are a few of the many natural conditions which would tend to modify the digestibility of the flesh and render generalizations from even a large number of results somewhat uncertain.

The outcome of their work is expressed thus:

The results of the analyses show plainly that the method adopted is as good as could be expected, for it must be remembered that the two results obtained from each sample of flesh are not merely from duplicated analyses, but from duplicated digestions as well, and in these, extending as they do over 22 hours, with slight variations in temperature and agitation, small differences are to be expected. The very great divergence noticed, however, in the results obtained from different samples of the same species of flesh shows at once that there are other conditions, such as age, etc., which affect the digestibility of the flesh more or less, so that in order to obtain results from which to draw strict generalizations it would be necessary to experiment with fish of different species, of like age, sex, and reared under like conditions. As samples of this we have the very divergent results from two samples of veal, and also of two bluefish (88.69 and 73.44). As direct evidence that age, sex, etc., do exert a modifying influence on the digestibility of flesh, we have three experiments on the flesh of the lobster; one with a small young lobster, a second with a large female, and a third with a large male of the same species. The duplicate digestions gave fairly concordant results; the average relative digestibility being for the young specimen 87.81, for the large female 79.06, and for the male 69.13. This shows plainly some modifying influence in flesh itself. In composition, so far as the solid matter is concerned, there was no appreciable difference in the three samples. Bearing in mind, however, these possible variations, it is very evident from our results that the average digestibility of fish flesh is far below that of beef similarly cooked. In but two instances, in the case of shad and whitefish, does the digestibility of fish flesh approach that of beef, although from the average of our experiments several are as easily digestible as mutton, lamb, and chicken.

Pavy states that fish with white flesh, such as the whiting, etc., are less stimulating

and lighter to the stomach, or more easy of digestion, than fish with more or less red flesh, as the salmon. Our experiments confirm this statement so far as digestibility is concerned. Thus the average digestibility of the salmon and trout is considerably below the average of the more digestible whitefish. The difference between the digestibility of the light and the dark meat of the same flesh is somewhat striking, as in the case of the shad, where the digestibility of the former was found to be 97.25, as compared with beef, while the dark flesh was 87.32. A similar difference, though very much smaller, is to be noticed between the light and dark meat of the chicken.

This difference in digestibility is in part due, without doubt, to the amount of fat present, for, as Pavy states, in the flesh of the white fish there is but little fat, it being accumulated mainly in the liver of the animal, while in red fish there is more or less fatty matter incorporated with the muscular fibers. For a similar reason eels, mackerel, and herring are, according to Pavy, less suited to a delicate stomach than some of the white fish, and our experiments show that in digestibility two of them stand below the more digestible white fish; mackerel, however, from our single experiment with the white portion of the flesh, showed a comparatively high digestibility. In all of our experiments, however, with white fish we rejected the outer layer of dark flesh, except in the case of the shad. The varying differences in digestibility are not to be considered as due wholly to differences in the amount of fat in the flesh; thus the flesh of fresh cod contains but little fat, and yet it is one of the most indigestible of the white fish experimented with. This agrees with Pavy's experience "that it is a more trying article of food to the stomach than is generally credited." Again Pavy makes the following statement, based on his experience in fish dietetics: "Of all fish the whiting may be regarded as the most delicate, tender, and easy of digestion." "The haddock is somewhat closely allied, but is inferior in digestibility," while "the flounder is light and easy of digestion, but insipid." With all these statements our results agree perfectly, assuming the white fish of our experiments to be analogous to the English whiting.

It thus appears that Messrs. Chittenden and Cummins found considerable divergence in the digestibility of the flesh of fishes of different kinds. This they attribute in part to the varying proportions of fat (the fatter fish being less digestible) and in part to other characteristics of the flesh. My own impression is that experiments on the actual digestion in the alimentary canal, in which other juices as well as the gastric come in play and other conditions are different, would show less difference in the digestibility of fish of different sorts than Chittenden and Cummins found in their experiments in artificial digestion with gastric juice alone, and also that there would be less variation in actual quantities and nutritive material digested than the statements made by those authors would imply; for we must not forget the distinction between the quantity digested and the ease of digestion. But of course this is a matter to be determined by actual experiments and observation.

The ways for testing the digestibility of foods by men and animals are very ingenious and interesting. Physiologists use the salivary glands, stomach, or intestines of a living animal much as chemists do their bottles, retorts, and test tubes. It is easy to get into the way of regarding an animal as simply an organism manifesting certain reactions under given conditions, and in not a few European laboratories a janitor is readily induced by the price of a few months' supply of beer, or a student by his scientific ardor, to take this same altruistic view of his own physical organisms. In the German laboratories par-

ticularly one finds not only the needed apparatus but (what is no less important) trained assistants and servants, so that one is relieved of much of the time-consuming and disagreeable detail of experimenting, which is so much of an obstacle with us.

THE QUANTITIES OF DIGESTIBLE SUBSTANCES IN FOOD.

The first question we have now to ask may be put in this way: What proportion of each of the nutrients in different food materials is actually digestible? In a piece of meat, for instance, what percentage of the total protein and fats will be digested by a healthy person and what proportion of each will escape digestion? The proportions of food constituents digested by domestic animals has been a matter of active investigation in the European agricultural experiment stations during the past twenty years. Briefly expressed, the method consists in weighing and analyzing both the food consumed and the intestinal excretion, which latter represents the amount of food undigested. The difference is taken as the amount digested.

Such experiments upon human subjects, however, are rendered much more difficult by the fact that in order that the digestibility of each particular food material may be determined with certainty we must avoid mixing it with other materials; hence the diet during the experiments must be so plain and simple as to make it extremely unpalatable. An ox will live contentedly on a diet of hay for an indefinite time, but for an ordinary man to subsist a week on meat, or fish, or potatoes, or eggs is a very different matter. No matter how palatable such a simple food may be at first, to a man used to the ordinary diet of a well-to-do community, it will almost certainly become repugnant to him after a few days. In consequence the digestive functions are disturbed and the accuracy of the trial is impaired, a fact, by the way, which strikingly illustrates the importance of varied diet in civilized life. For instance, in an experiment conducted in the physiological laboratory at Munich by Dr. Rubner, the subject, a strong healthy Bavarian laboring man, lived for three days upon bread and water, a diet the monotony of which was much more endurable than one of meat or fish or almost any other single food material would have been. He was able to eat 1,185 grammes (about 21 pounds and 10 ounces) of bread per day. This contained 670 grammes of carbohydrates, mainly starch, of which only about $5\frac{1}{3}$ grammes, or a little less than 1 per cent., escaped digestion.

In this case, therefore, about 99 per cent. of the carbohydrates of the bread was digested. The bread contained 13 grammes of protein, of which 13 per cent. was undigested, and 87 per cent., or seven-eighths of the whole protein, digested. The quantity of fatty matters in the bread was too small to permit an at all accurate test of their digestibility. In another experiment the digestibility of meat (beefsteak) was tested. The man consumed a little less than 2 pounds per day, but though it was cooked with butter, pepper, salt, and onions, so as to make it taste

"extraordinarily well flavored," it was very difficult to swallow it the second day and required great effort the third. The digestion, however, seemed to be normal, and all but about 1 per cent. of the protein was digested. Other trials with meat and with fish have brought similar results, and it is reasonably safe to say that when a healthy person with sound digestive organs eats ordinary meat in proper quantities all or nearly all of the protein is digested. Some of the fats of meats, however, seem to fail of digestion.

The number of accurate experiments of this kind is still very small. Some sixty or thereabouts have been reported. Nearly all have been made within 10 years past, and the majority in one laboratory, that of the University of Munich. Most of the subjects have been men with healthy digestive organs, two or three laboratory servants, a soldier, several medical students, and a few others. Several have been made, however, with children of a few families; all but a very small number were conducted in Germany.

Sometime since it was my fortune to pass a number of months in Munich, where, through the courtesy of Professor Voit, director of the Physiological Institute of the university, I was enabled to make some experiments on the digestion of meat and fish by a man and by a dog. Each lived for 3 days upon haddock, and then for 3 days upon lean meat, beefsteak. The dog was used to such experiments, and got on very comfortably, indeed. The meat and fish were each cooked with a little lard. He did not take to the fish at first, but after he got used to it seemed to like it. The first attempt with a man was with the same healthy, rather stolid, Bavarian laborer with whom Dr. Rubner's experiments with meat and bread, above referred to, were performed. He bore up very well through the trials with both the fish and meat, but the assistant discovered at the end that he had surreptitiously eaten sourcrout, and the experiment was spoiled.

Fortunately, a medical student, then working in the laboratory, became interested in the subject, and offered himself as a martyr to the cause. He had for 3 days flesh of haddock fried with butter, flavored with salt, pepper, mustard, and Worcestershire sauce, and taken with beer and wine. Then came a period of rest; that is to say, ordinary diet, and then a similar trial of beefsteak. I was with him at every meal and can bear warm testimony to his fortitude and determination. The menu was made as appetizing as possible under the circumstances. The first day of each trial went pretty well, the second day it was difficult, and the third day extremely so, to swallow the whole. As the result, it appeared that he digested nearly the whole of both the meat and the fish. The results of the experiments are stated in tabular form herewith. The percentage of each ingredient which escaped digestion is given. In some case a correction for certain errors of experiment, which need not be discussed here, is applied to the figures for amounts "apparently undigested," to show those estimated to be "actually" digested.

Summary of results of experiments on the digestion of the constituents of meat and fish by a dog and by a man. Percentages undigested.

Food.	Dog.		Man.	
	Meat and lard.	Fish and lard.	Meat, butter, etc.	Fish, butter, etc.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water-free substance, apparently undigested	3.4	3.2	4.3	4.9
Nitrogen (protein) from meat or fish, apparently undigested	2.2	1.6	2.5	2.0
Nitrogen (protein) from meat or fish actually undigested	0.3	0.0	0.7	0.5
Fat, mostly from lard or butter, apparently undigested	2.8	3.0	5.2	9.0
Ash, apparently undigested	14.3	14.1	21.5	22.5

Practically all the protein of both the fish and lean beef were digested by the dog, and all but one-half or three-fourths of 1 per cent. by the man; these results agree with what would be expected from the nature of the nitrogen compounds and what is known of the laws of digestion and absorption, and leave little doubt that practically all of the protein of both will be digested by a healthy organism under normal conditions.

The conclusion that the flesh of the common kinds of fish agrees very closely in digestibility with that of the common kinds of meat, at least so far as the protein (the chief constituent of the "lean" of meat and fish) is concerned, seems equally well grounded. It would seem from other considerations (especially from actual experiments with meats, in which the fat is imperfectly digested) that fish, having generally less fat than meat, is more easily and completely digested.

It is interesting to note how different food materials compare in digestibility as shown by experiments such as those just described. Results of such trials are given in Table II of the previous chapter.

The amounts of fat in the vegetable foods are so small that the experiments do not tell exactly what proportions are digested. The meats and fish contain practically no carbohydrates. The digestibility of the carbohydrates (sugar) of milk was not determined; those of the vegetable foods, except the beets, were almost completely digested. That the protein of cow's milk should be so much less completely digested than that of meat seems a little strange. Children digest a little more than adults. Dr. Camerer found his boys and girls of from 2 to 12 years of age to digest from 91 to 97 per cent. of the protein of cow's milk, while grown men in experiments by Dr. Rubner digested from 88 to 94 per cent. But in experiments in which milk and cheese were eaten together by a man, in Dr. Rubner's experiments, all or nearly all of the protein of both was digested. The percentages of fats of milk digested were practically the same with adults as with children. It is noticeable that both children and adults digest only about half of the mineral salts of the milk. Why so much of the fats of the meat, from a twelfth to a fifth, should fail to be digested it is not easy to say. Some food materials, as meat, bread, and milk, have been tested by

several experiments with more than one person; with others, as eggs, corn meal, rice, pease, and potatoes, only a single trial has been made.

Doubtless extended series of tests would give averages differing more or less from these figures; some food materials may be more completely digested when taken in small quantities with others in the ordinary way than when so much is eaten and without any other food; these and other sources of slight error make more extended experiments very desirable; but enough has been done to show pretty clearly that—

1. The protein of our ordinary meats and fish is very readily and completely digestible.

2. The protein of vegetable foods is much less digestible than that of animal foods. Of that of potatoes and beets, for instance, a third or more may escape digestion and thus be useless for nourishment.

3. Much of the fat of animal food may at times fail of digestion.

4. The carbohydrates, other than fiber, which make up the larger part of vegetable foods, are very digestible.

5. Animal foods have in general the advantage of vegetable foods in containing more protein; and their protein is more digestible.

6. The comparative digestibility of fish and meats and of the different kinds of fish is not well enough decided by experiment to warrant as definite conclusions as are desirable. The leaner meats are probably more easily digested than those with more fat, and the leaner kinds of fish, such as cod, haddock, perch, pike, bluefish, sole, flounder, etc., are more easily and completely digested than the fatter kinds, as salmon, shad, and fat mackerel; and fish, which is, in general, less fat than meat, is on the average more digestible.

7. People differ in respect to the action of foods in the digestive apparatus, and fish, like other food materials, are subject to these influences of personal peculiarity.

3. TABLES OF ANALYSES OF FISHES, MOLLUSKS, ETC.

TABLE VI. (CHART A.)—*Recapitulation of analyses of American and European food-fishes. Nutrients and water in flesh (edible portion).*

[Arranged in order from those with largest to those with smallest percentages of total nutrients.]

Kinds of fish. (A, American; E, European.)	In flesh. Protein.	Fats.	Ash.	Total.	Water.	Energy in 1 pound of each material.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
California salmon, A.:						
Maximum	16.96	19.25	1.11	37.32	62.68	1,125
Minimum	17.96	16.50	1.01	35.47	64.53	1,030
Average	17.46	17.87	1.06	36.39	63.61	1,080
Eel, A and E:						
Maximum	13.42	32.88	0.92	47.22	52.78	1,635
Minimum	17.61	7.88	1.11	26.60	73.40	660
Average	15.82	18.74	0.93	35.49	64.51	1,085
Salmon, A and E:						
Maximum	24.45	13.07	1.45	38.97	61.03	1,005
Minimum	18.17	4.85	1.28	24.30	75.70	545
Average	20.77	12.09	1.38	34.24	65.76	895
Spanish mackerel, A	20.97	9.43	1.50	31.90	68.10	790

TABLE VI. (CHART A.)—*Recapitulation of analyses of American and European food-fishes. Nutrients and water in flesh, edible portion*—Continued.

Kinds of fish. (A, American; E, European.)	In flesh. Protein.	Fats.	Ash.	Total.	Water.	Energy in 1 pound of each material.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Lake trout, A:						
Maximum	17.32	12.55	1.35	31.22	68.78	850
Minimum	19.12	10.21	1.17	30.50	69.50	785
Average	18.22	11.38	1.26	30.86	69.14	820
Whitefish, A	22.06	6.49	1.62	30.17	69.83	685
Butterfish, A	17.81	11.03	1.14	29.98	70.02	795
Shad, A:						
Maximum	19.68	13.59	1.48	34.75	62.25	940
Minimum	18.05	7.03	1.36	26.44	73.56	630
Average	18.55	9.48	1.35	29.38	70.62	745
Lamprey eel, A	14.93	13.29	0.66	28.88	71.12	840
Turbot, A	12.92	14.41	1.28	28.61	71.39	850
Mackerel, A and E:						
Maximum	18.21	16.30	1.48	35.99	64.01	1,025
Minimum	18.13	2.20	1.00	21.33	78.67	430
Average	18.77	8.21	1.40	28.38	71.62	695
Herring, A and E:						
Maximum	18.46	11.01	1.50	30.97	69.03	810
Minimum	17.29	4.89	1.71	23.89	76.11	530
Average	18.19	8.02	1.69	27.90	72.10	675
Pompano, A:						
Maximum	18.15	13.51	0.96	32.62	67.38	910
Minimum	19.15	1.64	1.03	21.82	78.18	425
Average	18.65	7.57	1.00	27.22	72.78	665
Bleak, E	15.73	8.13	3.25	27.11	72.89	635
Alewife, A:						
Maximum	19.54	6.02	1.48	27.04	72.96	620
Minimum	18.80	3.82	1.46	24.08	75.92	510
Average	19.17	4.92	1.47	25.56	74.44	565
Small-mouthed black bass, A	21.50	2.44	1.24	25.18	74.82	505
Mullet, A	19.32	4.64	1.17	25.13	74.87	555
Porgy, A:						
Maximum	18.81	7.86	1.35	28.02	71.98	680
Minimum	17.46	1.46	1.40	20.32	79.68	390
Average	18.52	5.11	1.38	25.01	74.99	560
Salmon trout, E	20.83	2.49	1.33	24.65	75.35	490
Halibut, A:						
Maximum	18.16	10.57	1.14	29.87	70.13	785
Minimum	17.49	2.21	1.15	20.85	79.15	420
Average	18.35	5.18	1.05	24.58	75.42	560
Sheepshead, A:						
Maximum	20.17	6.72	1.10	27.99	72.01	660
Minimum	18.93	0.66	1.33	20.92	79.08	380
Average	19.54	3.69	1.22	24.45	75.55	520
White perch, A:						
Maximum	17.63	5.62	1.11	24.36	75.64	565
Minimum	20.43	2.52	1.28	24.23	75.77	485
Average	19.03	4.07	1.19	24.29	75.71	525
Pollock, A	21.65	0.78	1.55	23.98	76.02	435
Sturgeon, E	17.67	5.15	1.16	23.98	76.02	545
Cisco, A	19.12	3.48	1.25	23.85	76.15	505
Muskellunge, A	19.63	2.54	1.57	23.74	76.26	470
Sterlet, E	16.64	5.59	0.96	23.19	76.81	545
Gudgeon, E	16.99	2.68	3.44	23.11	76.89	430
Plaice, E	19.35	1.80	1.46	22.61	77.39	435
Striped bass, A:						
Maximum	19.33	3.64	1.27	24.24	75.76	515
Minimum	16.87	2.14	1.36	20.37	79.63	405
Average	18.31	2.83	1.16	22.30	77.70	460
Brook trout, A:						
Maximum	20.03	2.94	1.25	24.22	75.78	495
Minimum	18.45	0.75	0.96	20.16	79.84	375
Average	18.97	2.10	1.21	22.28	77.72	440
Smelt, E	16.97	3.08	1.57	21.62	78.38	445
Carp, E:						
Maximum	20.60	1.09	1.34	23.03	76.97	420
Minimum	17.55	1.42	1.14	20.11	79.89	385
Average	19.07	1.26	1.24	21.57	78.43	405
Red snapper, A:						
Maximum	19.39	1.94	1.33	22.66	77.34	440
Minimum	18.31	0.54	1.34	20.19	79.81	365
Average	19.20	1.03	1.31	21.54	78.46	400
Bluefish, A	19.02	1.25	1.27	21.54	78.46	405
Large-mouthed black bass, A	19.24	0.96	1.19	21.39	78.61	400
Small-mouthed red-horse, A	17.90	2.35	1.19	21.44	78.56	430
Sturgeon, A	17.96	1.90	1.43	21.29	78.71	415

TABLE VI. (CHART A.)—*Recapitulation of analyses of American and European food-fishes. Nutrients and water in flesh (edible portion)*—Continued.

Kinds of fish. (A, American; E, European.)	In flesh. Protein.	Fats.	Ash.	Total.	Water.	Energy in 1 pound of each material.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Skate, A and E:						
Maximum	22.32	0.47	1.71	24.50	75.50	435
Minimum	15.32	1.39	1.14	17.85	82.15	345
Average	18.82	0.93	1.43	21.18	78.82	390
Weakfish, A	17.45	2.39	1.19	21.03	78.97	425
Blackfish, A:						
Maximum	18.96	2.81	1.28	23.05	76.95	470
Minimum	17.44	0.55	0.65	18.64	81.36	350
Average	18.47	1.35	1.08	20.90	79.10	400
Whitefish, E	18.12	1.53	1.22	20.87	79.13	400
Smelt, A:						
Maximum	18.83	1.65	1 36	21.84	78.16	420
Minimum	15.90	1.94	2.00	19.84	80.16	375
Average	17.36	1.80	1.68	20.84	79.16	400
Kingfish, A	18.66	0.95	1.18	20.79	79.21	385
Sea bass, A	18.75	0.49	1.44	20.68	79.32	370
Dab, E	16.59	2.06	1.94	20.59	79.41	395
Grouper, A:						
Maximum	19.15	0.75	1.14	21.04	78.96	385
Minimum	18.41	0.48	1.16	20.05	79.95	365
Average	18.80	0.60	1.15	20.55	79.45	375
Yellow perch, A and E:						
Maximum	19.47	1.12	1.34	21.93	78.07	410
Minimum	17.88	0.55	1.14	19.57	80.43	355
Average	18.49	0.70	1.29	20.48	79.52	375
Pike perch, Wall-eyed pike, A	18.42	0.47	1.37	20.26	79.74	360
Pickerel, A:						
Maximum	18.88	0.49	1.11	20.48	79.52	370
Minimum	18.40	0.52	1.24	20.16	79.84	365
Average	18.64	0.50	1.18	20.32	79.68	370
Pike perch, E	18.93	0.20	1.00	20.13	79.87	360
Conger eel, E	13.96	5.02	1.11	20.09	79.91	470
Pike, A and E:						
Maximum	20.58	0.60	1.29	22.47	77.53	410
Minimum	14.83	0.15	1.13	16.11	83.89	285
Average	17.95	0.41	1.16	19.52	80.48	350
Pike perch, Gray pike, A	17.26	0.76	1.13	19.15	80.85	355
Crucian carp, E	17.63	0.48	1.07	19.18	80.82	350
Russian cod, E	16.48	0.59	1.58	18.65	81.35	330
Haddock, A and E:						
Maximum	18.38	0.17	1.15	19.70	80.30	350
Minimum	15.94	0.32	1.18	17.44	82.56	310
Average	17.10	0.26	1.25	18.61	81.39	330
Tomcod, A	17.08	0.38	0.99	18.45	81.55	335
Red bass, A	16.68	0.53	1.23	18.44	81.56	335
Cusk, A	16.92	0.17	0.90	17.99	82.01	320
Cod, A and E:						
Maximum	17.59	0.30	1.40	19.29	80.71	340
Minimum	14.97	0.28	1.27	16.52	83.48	290
Average	16.00	0.30	1.24	17.54	82.46	310
Whiting, E	15.59	0.38	1.08	17.05	82.95	305
Hake, A	15.24	0.67	0.98	16.89	83.11	310
Common flounder, A:						
Maximum	14.73	0.62	1.28	16.63	83.37	300
Minimum	12.90	0.77	1.29	14.96	85.04	270
Average	13.82	0.69	1.28	15.79	84.21	285
Winter flounder, A	14.01	0.44	1.20	15.65	84.35	280
Sole, E	12.38	0.25	1.23	13.86	86.14	240
Barbel, E	9.54	0.21	0.90	10.65	89.35	185
SPENT FISH.						
Spent salmon, A:						
Maximum	19.24	4.37	1.12	24.73	75.27	540
Minimum	17.80	2.83	1.17	21.80	78.20	450
Average	18.52	3.60	1.14	23.26	76.74	495
Spent land-locked salmon, A:						
Maximum	16.84	4.01	1.27	22.12	77.88	485
Minimum	17.65	1.95	1.20	20.80	79.20	410
Average	17.24	2.98	1.24	21.46	78.54	445

TABLE VII. (CHART B.)—*Nutritive ingredients, water and salt in flesh (edible portion) of specimens of American and European preserved fish.*

Fish. (A, American; E, European.)	No. of specimens analyzed.	Edible portion.					Energy in 1 pound of each material.	Salt.
		Nutrients.				Water.		
		Protein.	Fats.	Ash.	Total.			
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calor.	Pr. ct.
Desiccated codfish (fish meal) A	1	74.46	1.90	5.41	84.75	15.25	1,465	2.88
Fish meal, Gadus sp., E	1	73.55	0.70	8.73	82.98	17.02	1,395	......
Dried codfish, stock fish, E	1	78.20	1.20	6.89	86.29	13.71	1,505	......
Salt codfish, A	3	21.42	0.34	1.62	46.42	53.58	419	23.04
Salt mackerel, A	3	18.88	25.12	2.59	56.99	43.01	1,410	10.40
Salt herring, E	4	20.17	14.44	1.90	51.42	48.58	985	14.91
Salted smelt, E	1	26.38	8.03	5.33	52.88	47.12	....	13.14
Salted salmon, E	1	22.68	12.19	0.44	46.52	53.48	935	11.21
Smoked haddock, A	1	33.68	0.17	1.53	27.44	72.56	445	2.06
Smoked halibut, A	2	20.57	15.03	2.06	50.62	49.38	1,015	12.96
Smoked herring, A	1	36.44	15.82	1.53	65.45	34.55	1,345	11.66
Smoked sprat, E	1	23.71	15.94	0.46	40.11	59.89	1,115	......
Smoked anchovy, E	1	22.75	2.21	2.68	48.23	51.77	515	20.59
Smoked salmon, E	2	24.63	11.86	1.17	48.53	51.47	960	10.87
Canned sardines, E	1	25.31	12.71	5.61	43.63	56.37	1,010	......
Canned salmon, A	3	20.06	15.70	1.32	38.12	61.88	1,035	1.04
Canned mackerel, A	1	19.91	8.68	1.30	31.82	68.18	735	1.93
Canned tunny, A	1	21.52	4.05	1.69	27.26	72.74	570	......

TABLE VIII. (CHART C.)—*Recapitulation of analyses of American and European fishes. Nutrients, water, and refuse, in specimens as purchased.*

[Arranged in order, from those with largest to those with smallest percentages of total nutrients.]

Kinds of fish and portions taken for analysis. (A, American; E, European.)	No. of specimens analyzed.	Edible portion.						Energy in 1 pound of each material.	Refuse.	
		Nutrients.				Water.	Total.		Bones, skin, entrails, etc.	Salt.
		Protein.	Fats.	Ash.	Total.					
FRESH FISH.		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	Calories.	P. ct.	P. ct
California salmon, sections of body, A	2	16.5	17.0	1.0	34.5	60.3	94.8	1,024	5.2	...
Eel, whole, E	1	8.6	21.0	0.6	30.2	33.8	64.0	1,045	36.0	....
Salmon, whole, A:										
Maximum	1	13.3	10.0	1.0	24.3	42.2	66.5	670	33.5	....
Minimum	....	13.9	9.3	1.0	24.2	45.0	69.2	650	30.8	....
Average	....	14.3	8.8	1.0	24.1	40.6	64.7	635	35.3	....
Eel, skin, head, and entrails removed, A:										
Maximum	....	14.9	8.1	0.7	23.7	54.9	78.6	620	21.4	...
Minimum	....	14.3	6.4	0.9	21.6	59.4	81.0	535	19.0	...
Average	....	14.6	7.2	0.8	22.6	57.2	79.8	575	20.2	....
Spanish mackerel, A, whole	1	13.7	6.2	1.0	20.9	44.5	65.4	516	34.6	....
Halibut, sections of body, A:										
Maximum	....	16.1	9.4	1.0	26.5	62.3	88.8	695	11.2	....
Minimum	....	15.8	2.2	0.7	18.7	62.6	81.3	385	18.7	....
Average	....	15.1	4.4	0.9	20.4	61.9	82.3	465	17.7	....
Lake trout, entrails removed, A	1	12.4	6.6	0.8	19.8	45.0	64.8	508	35.2	....
Pollock, head and entrails removed, A	1	15.5	0.6	1.1	17.2	54.3	71.5	313	28.5	....
Butter-fish, whole, A	1	10.2	6.3	0.6	17.1	40.1	57.2	456	42.8	....
Herring, whole, A	1	10.0	5.9	0.8	16.7	37.3	54.0	435	46.0	....
Lamprey eel, whole, A	1	8.1	7.2	0.4	15.7	38.5	54.2	454	45.8	...
Mackerel, entrails removed, A	1	11.4	3.5	0.7	15.6	43.7	59.3	360	40.7	...
Mackerel, whole, A:										
Maximum	....	12.1	10.7	1.0	23.8	42.4	66.2	675	33.8	....
Minimum	....	9.5	2.1	0.6	12.2	37.4	49.6	265	50.4	....
Average	....	10.0	4.3	0.7	15.0	40.4	55.4	370	44.6	....
Turbot, whole, A	1	6.8	7.5	0.7	15.0	37.3	52.3	442	47.7	....
Pompano, whole, A:										
Maximum	....	10.5	7.8	0.5	18.8	38.8	57.6	525	42.4	....
Minimum	....	9.9	0.8	0.5	11.2	40.2	51.4	220	48.6	....
Average	....	10.2	4.3	0.5	15.0	39.5	54.5	370	45.5	....
Little herring, whole, E	....	10.6	3.2	0.9	14.7	40.3	55.0	332	45.0	....

TABLE VIII. (CHART C.)—*Recapitulation of analyses of American and European fishes. Nutrients, water, and refuse, in specimens as purchased*—Continued.

[Arranged in order, from those with largest to those with smallest percentages of total nutrients.]

Kinds of fish and portions taken for analysis. (A, American; E, European.)	No. of specimens analyzed.	Edible portion.						Energy in 1 pound of each material.	Refuse.	
		Nutrients.				Water.	Total.		Bones, skin, entrails, etc.	Salt.
		Protein.	Fats.	Ash.	Total.					
FRESH FISH—Continued.										
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	Calories.	P. ct.	
Shad, whole, A:										
Maximum	....	10.5	7.3	0.8	18.6	35.0	53.6	505	46.4	....
Minimum	....	7.4	2.9	0.6	10.9	30.3	41.2	260	58.8	....
Average	....	9.2	4.8	0.7	14.7	35.2	49.9	375	50.1	....
Yellow perch, head and entrails removed, A	1	12.6	0.7	0.9	14.2	50.7	64.9	263	35.1	....
Whitefish, whole, A	1	10.3	3.0	0.7	14.0	32.5	46.5	319	53.5	....
Cisco, whole, A	1	11.0	2.0	0.7	13.7	43.6	57.3	289	42.7	....
Lake trout, whole, A	1	7.7	5.4	0.6	13.7	30.0	43.7	371	56.3	....
Red snapper, whole, A	1	11.9	0.4	0.8	13.1	46.9	60.0	239	40.0	....
Alewife, whole, A:										
Maximum	....	9.9	3.0	0.8	13.7	36.9	50.6	310	49.4	....
Minimum	....	9.5	1.9	0.8	12.2	38.3	50.5	255	49.5	....
Average	....	9.7	2.5	0.8	13.0	37.5	50.5	285	49.5	....
Sheepshead, entrails removed, A	1	8.8	2.9	0.5	12.2	31.3	43.5	285	56.5	....
Muskellunge, whole, A	1	10.0	1.3	0.8	12.1	38.7	50.8	241	49.2	....
Smelt, whole, A:										
Maximum	....	10.4	1.2	1.3	12.9	52.3	65.2	245	34.8	....
Minimum	....	9.6	0.8	0.7	11.1	39.9	51.0	215	49.0	....
Average	....	10.0	1.0	1.0	12.0	46.1	58.1	230	41.9	....
Small-mouthed black bass, whole, A	1	10.0	1.1	0.6	11.7	34.7	46.4	232	53.6	....
Cod, head and entrails removed, A:										
Maximum	....	11.4	0.2	0.8	12.4	62.1	74.5	220	25.5	....
Minimum	....	9.9	0.2	0.9	11.0	55.3	66.3	190	33.7	....
Average	....	10.6	0.2	0.8	11.6	58.5	70.1	205	29.9	....
Pike, whole, A	1	10.7	0.3	0.6	11.6	45.7	57.3	212	42.7	....
Brook trout, whole, A:										
Maximum	....	10.2	1.5	0.6	12.3	38.6	50.9	255	49.1	....
Minimum	....	10.1	0.4	0.5	11.0	43.8	54.8	205	45.2	....
Average	....	9.8	1.1	0.6	11.5	40.4	51.9	230	48.1	....
Striped bass, entrails removed, A	1	8.7	2.2	0.5	11.4	37.4	48.8	253	51.2	....
Bluefish, entrails removed, A	1	9.8	0.6	0.7	11.1	40.3	51.4	207	48.6	....
Red snapper, entrails removed, A:										
Maximum	....	10.0	0.3	0.7	11.0	43.7	54.7	200	45.3	....
Minimum	....	9.2	0.9	0.6	10.7	36.8	47.5	210	52.5	....
Average	....	9.6	0.6	0.6	10.8	40.3	51.1	205	48.9	....
Pickerel, whole, A:										
Maximum	....	10.0	0.3	0.7	11.0	43.6	54.6	200	45.4	....
Minimum	....	9.7	0.2	0.6	10.5	40.8	51.3	190	48.7	....
Average	..	9.8	0.2	0.7	10.7	42.2	52.9	190	47.1	....
Cusk, entrails removed, A	1	10.1	0.1	0.5	10.7	49.0	59.7	192	40.3	....
Mullet, whole, A	1	8.1	2.0	0.5	10.6	31.5	42.1	235	57.9	....
Small-mouthed red-horse, with entrails removed, A:	1	8.5	1.1	0.6	10.2	37.3	47.5	203	52.5	....
Weakfish, whole, A	1	8.4	1.1	0.6	10.1	38.0	48.1	201	51.9	....
Porgy, whole, A:										
Maximum	....	8.0	3.4	0.6	12.0	30.7	42.7	295	57.3	....
Minimum	....	6.1	0.5	0.5	7.1	27.8	34.9	135	65.1	....
Average	....	7.4	2.1	0.6	10.1	29.9	40.0	225	60.0	....
Striped bass, whole, A:										
Maximum	....	9.7	1.4	0.6	11.7	39.7	51.4	240	48.6	....
Minimum	....	7.2	0.9	0.6	8.7	34.4	43.1	170	56.9	....
Average	....	8.3	1.1	0.6	10.0	35.1	45.0	200	54.9	....
Large-mouthed black bass, whole, A	1	8.5	0.4	0.5	9.4	34.6	44.0	174	56.0	....
Blackfish, entrails removed, A:										
Maximum	....	8.7	0.7	0.6	10.0	36.4	46.4	190	53.6	....
Minimum	....	7.9	0.4	0.4	8.7	33.5	42.2	165	57.8	....
Average	....	8.3	0.5	0.5	9.3	35.0	44.3	175	55.7	....
White perch, whole, A:										
Maximum	....	7.8	1.0	0.5	9.3	28.9	38.2	185	61.8	....
Minimum	....	6.5	2.1	0.4	9.0	27.8	36.8	210	63.2	....
Average	....	7.2	1.5	0.4	9.1	28.4	37.5	195	62.5	....
Sea bass, whole, A	1	8.3	0.2	0.6	9.1	34.8	43.9	162	56.1	....
Red grouper, entrails removed, A:										
Maximum	....	8.5	0.3	0.5	9.3	34.8	44.1	170	55.9	....
Minimum	....	8.2	0.2	0.5	8.9	35.3	44.2	160	55.8	....
Average	....	8.4	0.2	0.5	9.1	35.0	44.1	165	55.9	....
Kingfish, whole, A	1	8.1	0.4	0.5	9.0	34.4	43.4	168	56.6	....

TABLE VIII. (CHART C).—*Recapitulation of analyses of American and European fishes. Nutrients, water and refuse in specimens as purchased*—Continued.

[Arranged in order, from those with largest to those with smallest percentages of total nutrients.]

Kinds of fish and portions taken for analysis. (A, American; E, European).	No. of specimens analyzed.	Edible portion. Nutrients. Protein.	Fats.	Ash.	Total.	Water.	Total.	Energy in 1 pound of each material.	Refuse. Bones, skin, entrails, etc.	Salt.
FRESH FISH—Continued.										
								Calories.		
Haddock, entrails removed, A:		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.		P. ct.	P.c.
Maximum	....	8.9	0.1	0.6	9.6	39.0	48.6	170	51.4	....
Minimum	....	7.9	0.2	0.5	8.6	38.5	47.1	155	52.9	....
Average	....	8.2	0.2	0.6	9.0	40.0	49.0	160	51.0	....
Cod, whole, A:										
Maximum	....	8.3	0.3	0.6	9.2	42.3	51.5	165	48.5	....
Minimum	....	7.7	0.1	0.6	8.4	35.1	43.5	145	56.5	....
Average	....	8.0	0.2	0.6	8.8	38.7	47.5	155	52.5	....
Wall-eyed pike, whole, A	1	7.9	0.2	0.6	8.7	34.1	42.8	155	57.2	....
Pike, whole, E	2	7.8	0.1	0.6	8.5	44.5	53.0	149	47.0	....
Blackfish, whole, A:										
Maximum	....	8.3	1.2	0.6	10.1	33.7	43.8	205	56.2	....
Minimum	....	6.3	0.2	0.2	6.7	29.2	35.9	125	64.1	....
Average	....	7.3	0.7	0.4	8.4	31.5	39.9	165	60.1	....
Yellow perch, whole, E	....	7.4	0.2	0.6	8.2	32.8	41.0	146	59.0	....
Hake, entrails removed, A	1	7.2	0.3	0.5	8.0	39.5	47.5	147	52.5	....
Tomcod, whole, A	1	6.8	0.2	0.4	7.4	32.7	40.1	134	59.9	....
Yellow perch, whole, A	1	6.7	0.2	0.4	7.3	30.0	37.3	133	62.7	....
Common flounder, entrails removed, A	1	6.3	0.3	0.6	7.2	35.8	43.0	130	57.0	....
Gray pike, whole, A	1	6.4	0.3	0.4	7.1	29.7	36.8	132	63.2	....
Sheepshead, whole, A	1	6.4	0.2	0.5	7.1	26.9	34.0	127	66.0	....
Winter flounder, whole, A	1	6.1	0.2	0.5	6.8	37.0	43.8	122	56.2	....
Red bass, whole, A	1	6.1	0.2	0.4	6.7	29.8	36.5	122	63.5	....
Common flounder, whole, A	1	5.2	0.3	0.5	6.0	27.2	33.2	110	66.8	....
SPENT FISH.										
Salmon, whole, A:										
Maximum	....	10.8	2.5	0.6	13.9	42.3	56.2	305	43.8	....
Minimum	....	10.0	1.6	0.7	12.3	44.2	56.5	255	43.5	....
Average	....	10.4	2.1	0.6	13.1	43.3	56.4	280	43.6	....
Land-locked salmon, whole, A:										
Maximum	....	8.7	2.1	0.6	11.4	40.2	51.6	250	48.4	....
Minimum	...	9.5	1.0	0.7	11.2	42.6	53.8	220	46.2	....
Average	....	9.1	1.6	0.6	11.3	41.4	52.7	235	47.3	....
Roe of shad	1	23.4	3.8	1.6	28.8	71.2	100.0	596	......	....
PRESERVED FISH.										
Desiccated cod, flesh ground, A	1	74.6	1.9	5.4	81.9	15.2	97.1	1,470	......	....
"Boneless cod," flesh of salt cod, A	1	22.1	0.3	4.1	26.5	54.4	80.9	424	......	19.1
Salt codfish, A	2	16.0	0.4	1.2	17.6	40.3	57.9	315	24.9	...
Salt mackerel, No. 1 mackerel, A	1	14.7	15.1	1.7	31.5	28.1	59.6	911	33.3	7.1
Salt herring, E	....	13.5	14.1	5.1	32.7	28.1	60.8	846	34.0	5.2
Salt little herring, E	....	11.9	4.3	6.5	22.7	33.9	56.6	404	39.0	4.4
Smoked herring, A	1	20.2	8.8	0.9	29.9	19.2	49.1	745	44.4	6.5
Smoked haddock, A	1	16.1	0.1	1.0	17.2	49.2	66.4	304	32.2	1.4
Smoked halibut, A	....	19.1	14.0	1.9	35.0	46.0	81.0	945	6.9	12.1
Canned sardines, A	1	24.0	12.1	5.3	41.4	53.6	95.0	956	5.0	....
Canned salmon, A	....	19.3	15.3	1.2	35.8	59.3	95.1	1,005	3.9	1.0
Canned fresh mackerel, A	2	19.9	8.7	1.3	29.9	68.2	98.1	737	......	1.9
Canned mackerel, No. 2 mackerel, A	....	13.8	21.3	2.1	37.2	34.8	72.0	1,156	......	8.3
Canned tunny, A	1	21.5	4.1	1.7	27.3	72.7	100.0	573	......	....
Canned smoked haddock, A	1	21.8	2.3	1.6	25.7	68.7	94.4	503	......	5.6

TABLE IX.—*Composition of the flesh (body) of oysters.*

[Arranged by percentages of water-free substance in flesh, from highest to lowest.]

Localities of specimens.	Specimen No.	Taken from beds.	Flesh in whole specimen.	In flesh.					
				Water.	Water-free substance.	In water-free substance.			
						Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference.)	Ash.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P.ct.
East River, N. Y	57	Apr., 1881	10.27	79.92	20.08	10.44	2.16	5.74	1.74
Do	108	Nov., 1881	11.91	75.22	24.78	10.07	2.87	9.97	1.87
Do (average of 2 specimens)	....	....	11.09	77.57	22.43	10.25	2.52	7.85	1.81
Potomac River, Va., transplanted * (2)	85	Nov., 1881	8.35	77.90	22.10	10.31	2.33	7.29	2.17
Oyster Bay, N. Y	180	Feb., 1882	10.85	77.90	22.10	10.61	2.35	6.95	2.19
James River, Va., transplanted* (2)	82	Nov., 1881	9.49	77.99	22.01	10.63	2.61	6.56	2.21
Blue Point, N. Y	56	Apr., 1881	13.39	76.77	23.23	10.28	2.30	8.72	1.93
Do	107	Nov., 1881	6.50	75.55	24.45	13.31	2.02	6.54	2.58
Do	182	Feb., 1882	8.01	83.97	16.03	8.81	1.62	4.01	1.59
Do (average of 3 specimens)	....	....	9.30	78.76	21.24	10.80	1.98	6.43	2.03
Potomac River, Va., transplanted † (1)	73	May, 1881	6.51	78.87	21.13	9.81	2.27	6.51	2.54
Providence River, R. I	70	...do	10.88	79.01	20.99	10.30	2.58	5.98	2.13
Fair Haven, Conn	54	Apr., 1881	12.63	81.30	18.70	9.89	2.05	4.56	2.20
Do	93	Nov., 1881	12.26	76.24	23.76	10.96	2.47	8.32	2.01
Do	210	Mar., 1882	12.19	80.80	19.20	9.89	2.05	5.41	1.85
Do (average of 3 specimens)	....	....	12.36	79.45	20.55	10.25	2.19	6.10	2.02
Rockaway, N. Y	58	Apr., 1881	10.68	81.27	18.73	9.18	2.13	5.75	1.67
Do	112	Nov., 1881	12.11	77.66	22.34	10.53	2.72	7.07	2.02
Do (average of 3 specimens)	....	....	11.40	79.46	20.54	9.85	2.43	6.41	1.85
Stony Creek, Conn	55	Apr., 1881	7.52	81.02	18.98	10.46	1.60	4.16	2.76
Do	75	May, 1881	7.34	82.09	17.91	9.88	1.48	4.00	2.55
Do	105	Nov., 1881	10.96	77.72	22.28	10.60	2.32	6.85	2.51
Do	203	Mar., 1882	11.17	80.42	19.58	10.38	1.85	5.13	2.22
Do (average of 4 specimens)	....	....	9.25	80.31	19.69	10.33	1.81	5.04	2.51
Shrewsbury, N. J	61	Apr., 1881	12.64	81.65	18.35	8.20	2.20	6.62	1.33
Do	106	Nov., 1881	11.27	77.58	22.42	9.68	2.66	8.20	1.88
Do	181	Feb., 1882	9.55	81.73	18.27	9.15	2.00	5.44	1.68
Do (average of 3 specimens)	....	....	11.15	80.32	19.68	9.01	2.29	6.75	1.63
Clinton, Conn	103	Nov., 1881	11.67	80.91	19.09	9.67	1.86	5.27	2.29
Norwalk, Conn	118	Dec., 1881	7.61	81.33	18.67	9.52	1.51	5.54	2.10
Do	151	Feb., 1882	7.27	80.50	19.50	9.97	1.89	5.49	2.15
Do (average of 2 specimens)	...	....	7.44	80.92	19.09	9.75	1.70	5.51	2.13
Long Island Sound, N. Y	60	Apr., 1881	9.13	84.47	15.53	8.14	1.68	4.30	1.41
Do	92	Nov., 1881	9.72	78.51	21.49	11.61	1.84	5.52	2.52
Do	109	...do	8.24	82.79	17.21	8.41	1.74	5.35	1.71
Do (average of 3 specimens)	....	....	9.03	81.92	18.08	9.39	1.75	5.06	1.88
Potomac River, Va., transplanted* (3)	84	Nov., 1881	10.18	82.06	17.94	9.09	1.93	5.34	1.58
Rappahannock River, Virginia, transplanted † (3).	72	May, 1881	7.86	82.64	17.36	8.51	1.90	5.37	1.58
James River, Va., transplanted* (3)	83	Nov., 1881	11.41	82.77	17.23	8.79	1.91	4.98	1.55
James River, Va., transplanted‡ (1)	71	May, 1881	6.50	83.49	16.51	8.26	1.78	4.76	1.71
Norfolk, Va	59	Apr., 1881	4.66	83.86	16.14	9.32	1.45	3.55	1.82
Buzzard's Bay, Mass	68	May, 1881	12.50	84.21	15.79	7.75	1.57	4.99	1.48
Maximum of 34 specimens	....	....	13.39	84.47	24.78	13.31	2.87	9.97	2.76
Minimum of 34 specimens	....	....	4.66	75.22	15.53	7.75	1.45	3.55	1.33
Average of 34 specimens	....	....	9.80	80.30	19.70	9.78	2.05	5.89	1.98

* Taken about six months after transplanting to New Haven, Conn.
† About three weeks after transplanting to New Haven, Conn.
‡ About five weeks after transplanting to New Haven, Conn.
(1) To New Haven, Conn. (2) Not floated. (3) Floated.

TABLE X.—*Composition of liquids (liquid portion) of oysters.*

[Arranged by percentages of water-free substance in liquids, from highest to lowest.]

Localities of specimens.	Specimen No.	Taken from beds.	Liquids in whole specimen.	In liquids.					
				Water.	Water-free substance.	In water-free substance.			
						Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference).	Ash.
			P.ct.	*P. ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
Fair Haven, Conn	54	Apr., 1881	5.43	94.00	6.00	2.08	0.02	0.71	3.19
Do	93	Nov., 1881	12 05	94.43	5.57	2.14	0.02	0.98	2.43
Do	210	Mar., 1881	4.40	95.38	4.62	1.80	0.03	0.71	2.08
Do (average of 3 specimens)	...	...	7.29	94.60	5.40	2.01	0.02	0.80	2.57
James River, Va., transplanted* (2)	82	Nov., 1881	5.51	94.74	5.26	1.95	0.05	0.72	2.54
Rockaway, N. Y	58	Apr., 1881	7.72	95.06	4.94	1.60	0.04	1.04	2.26
Do	112	Nov., 1881	7.73	94.79	5.21	1.76	0.01	0.88	2.56
Do (average of 2 specimens)		...	7.72	94.92	5.08	1.68	0.03	0.96	2.41
Potomac River, Va., transplanted *(2)	85	Nov., 1881	7.78	94.99	5.01	1.81	0.02	0.71	2.47
Providence River, R. I.	70	May, 1881	6.12	95.05	4.95	1.48	0.00	1.06	2.41
James River, Va., transplanted* (3)	83	Nov., 1881	5.73	95.22	4.78	2.09	0.13	1.14	1.42
East River, N. Y	57	Apr., 1881	10.01	95.44	4.56	1.67	0.02	1.30	1.57
Do	108	Nov., 1881	8.40	94 87	5.13	1.81	0.09	0.90	2.33
Do (average of 2 specimens)	...	...	9.21	95.15	4.85	1.74	0.06	1.10	1.95
Oyster Bay, N Y	180	Feb., 1882	6.42	95 31	4.69	1.46	0.01	0.85	2.37
Potomac River, Va., transplanted †(1)	73	May. 1881	5.64	95.51	4.49	1.45	0.01	0.56	2.47
Long Island Sound, N. Y	60	Apr., 1881	7.10	96.35	3.65	1.30	0.09	1.41	0.85
Do	92	Nov., 1881	4.90	93 81	6.19	2.29	0.02	0.72	3.16
Do	109	...do ...	9.35	96.64	3.36	1.09	0.01	0.39	1.87
Do (average of 3 specimens)		...	7.12	95.60	4.40	1.56	0.04	0.84	1.96
Potomac River, Va., transplanted *(3)	84	Nov., 1881	6.48	95.69	4.31	2.05	0.01	1.06	1.19
Shrewsbury, N. J	61	Apr., 1881	4.88	95.07	4.93	2.03	0.04	1.03	1.83
Do	106	Nov., 1881	8.40	95.35	4.65	1.88	0.04	0.77	1.96
Do	181	Feb., 1882	9.68	96.52	3.48	1.38	0.01	0.37	1.72
Do (average of 3 specimens)	...	...	7.66	95.65	4.35	1.76	0.03	0.72	1.84
Stony Creek, Conn	55	Apr., 1881	11.38	96.12	3.88	0.83	0.01	0.32	2.72
Do	75	May, 1881	11.81	96.33	3.67	0.65	0.05	0.36	2.61
Do	105	Nov., 1881	7.27	95.40	4.60	1.36	0.01	0.90	2.33
Do	203	Mar., 1882	9.33	95.30	4.70	1.42	0.03	0.75	2.50
Do (average of 4 specimens)		...	9.95	95.79	4.21	1.07	0.02	0.58	2.54
James River, Va., transplanted ‡ (1)	71	May, 1881	7.29	95.91	4.09	1.17	0.01	0.35	2.56
Clinton, Conn	103	Nov., 1881	13.20	96.02	3.98	1.10	0.02	0.65	2.21
Blue Point, N. Y	56	Apr., 1881	5.23	94.33	5.67	2.30	0.09	1.37	1.91
Do	107	Nov., 1881	9.67	96.89	3.11	0.75	0.01	0.45	1.90
Do	182	Feb., 1882	7.41	96.87	3.13	0.92	0.01	0.50	1.70
Do (average of 3 specimens)	..	...	7.44	96.03	3.97	1.32	0.04	0.77	1.84
Buzzard's Bay, Mass	68	May, 1881	7.51	96.40	3.60	1.23	0.00	0.74	1.63
Norwalk, Conn	118	Dec., 1881	10.24	96.46	3.54	0.79	0.01	0,42	2.32
Do	151	Feb., 1882	9.78	96.32	3.68	0.76	0.02	0.40	2.50
Do (average of 2 specimens)	...	...	10.01	96.39	3.61	0.77	0.02	0.41	2.41
Norfolk, Va	59	Apr., 1881	6.52	96.83	3.17	1.05	0.01	0.47	1.64
Rappahannock River, transplanted † (3)	72	May, 1881	7.31	97.24	2.76	1.01	0.01	0.36	1.38
Maximum of 34 specimens	...	...	13.20	97.24	6.19	2.30	0.13	1.41	3.19
Minimum of 34 specimens	...	...	4.40	93.81	2.76	0.65	0.00	0.32	0.85
Average of 34 specimens	...	...	7.87	95.61	4.39	1.48	0.03	0.75	2.13

* Taken about six months after transplanting to New Haven, Conn.
† About 3 weeks after transplanting to New Haven, Conn.
‡ About 5 weeks after transplanting to New Haven, Conn.
(1) To New Haven, Conn. (2) Not floated. (3) Floated.

TABLE XI.—*Composition of shell contents (flesh plus liquids) of oysters.*

[Arranged by percentages of water-free substance in shell contents from highest to lowest.]

Localities of specimens.	Specimen No.	Taken from beds.	Shell contents in whole specimen.	In shell contents. Water.	Water-free substance.	In water-free substance. Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference).	Ash
OYSTERS FROM SHELL.			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
James River, Va., transplanted *(4)	82	Nov., 1881	15.00	84.15	15.85	7.44	1.66	4.43	2.32
Oyster Bay, N. Y	180	Feb., 1882	17.27	84.37	15.63	7.21	1.48	4.68	2.26
Providence River, R. I	70	May, 1881	17.00	84.79	15.21	7.13	1.65	4.20	2.23
Fair Haven, Conn	54	Apr., 1881	18.06	85.12	14.88	7.54	1.43	3.41	2.50
Do	93	Nov., 1881	24.31	85.25	14.75	6.59	1.25	4.69	2.22
Do	210	Mar., 1882	16.59	84.67	15.33	7.74	1.51	4.17	1.91
Do (average of 3 specimens)			19.65	85.01	14.99	7.29	1.40	4.09	2.21
East River, N. Y	57	Apr., 1881	20.28	87.57	12.43	6.11	1.11	3.55	1.66
Do	108	Nov., 1881	20.31	83.35	16.65	6.65	1.72	6.22	2.06
Do (average of 2 specimens)			20.30	85.46	14.54	6.38	1.41	4.89	1.86
Rockaway, N. Y	58	Apr., 1881	18.40	87.06	12.94	6.02	1.25	3.76	1.91
Do	112	Nov., 1881	19.84	84.33	15.67	7.12	1.67	4.65	2.23
Do (average of 2 specimens)			19.12	85.69	14.31	6.57	1.46	4.21	2.07
Potomac River, Va., transplanted *(3)	85	Nov., 1881	16.13	86.14	13.86	6.20	1.21	4.13	2.32
Shrewsbury, N. J	61	Apr., 1881	17.52	85.39	14.61	6.48	1.60	5.06	1.47
Do	106	Nov., 1881	19.67	85.17	14.83	6.35	1.54	5.03	1.91
Do	181	Feb., 1882	19.23	89.16	10.84	5.24	1.00	2.91	1.69
Do (average of 3 specimens)			18.81	86.57	13.43	6.02	1.38	4.34	1.69
Potomac River, Va., transplanted †(1)	73	May, 1881	12.15	86.60	13.40	5.93	1.23	3.74	2.50
Blue Point, Patchogue, N. Y	56	Apr., 1881	18.62	81.70	18.30	8.04	1.68	6.66	1.92
Do.....Great South Bay, N. Y	107	Nov., 1881	16.17	88.30	11.70	5.80	0.82	2.90	2.18
Do.....L. I. Sound, N. Y	182	Feb., 1882	15.42	90.17	9.83	5.01	0.85	2.34	1.63
Do (average of 3 specimens)			16.74	86.72	13.28	6.28	1.12	3.97	1.91
James River, Va., transplanted *(3)	83	Nov., 1881	17.17	86.95	13.05	6.54	1.31	3.70	1.50
Potomac River, Va., transplanted *(4)	84	do	16.66	87.36	12.64	6.37	1.18	3.66	1.43
Long Island Sound, N. Y	60	Apr., 1881	16.23	89.67	10.33	5.15	0.99	3.03	1.16
Do	92	Nov., 1881	14.62	83.64	16.36	8.48	1.23	3.91	2.74
Do	109	do	17.59	90.15	9.85	4.52	0.82	2.71	1.80
Do (average of 3 specimens)			16.15	87.82	12.18	6.05	1.01	3.22	1.90
Stony Creek, Conn	55	Apr., 1881	18.90	90.11	9.89	4.66	0.64	1.83	2.76
Do	75	May, 1881	19.15	90.92	9.08	4.18	0.60	1.76	2.54
Do	105	Nov., 1881	18.23	84.83	15.17	6.94	1.39	4.42	2.42
Do	203	Mar., 1882	20.50	87.19	12.81	6.30	1.03	3.14	2.34
Do (average of 4 specimens)			19.20	88.26	11.74	5.52	0.91	2.79	2.52
Buzzard's Bay, Mass	68	May, 1881	20.01	88.80	11.20	5.31	0.99	3.37	1.53
Clinton, Conn	103	Nov., 1881	24.87	88.84	11.16	5.17	0.89	2.85	2.25
Rappahannock River, Va., transplanted †(4)	72	May, 1881	15.17	89.68	10.32	4.90	0.99	2.95	1.48
Norwalk, Conn	118	Dec., 1881	17.85	90.01	9.99	4.51	0.65	2.61	2.22
Do	151	Feb., 1882	17.05	89.58	10.42	4.68	0.81	2.58	2.35
Do (average of 2 specimens)			17.45	89.79	10.21	4.59	0.73	2.60	2.29
James River, Va., transplanted ‡(1)	71	May, 1881	13.79	90.05	9.95	4.53	0.84	2.43	2.15
Norfolk, Va	59	Apr., 1881	11.18	91.42	8.58	4.49	0.61	1.76	1.72
Maximum of 34 specimens			24.87	91.42	18.30	8.48	1.72	6.66	2.76
Minimum of 34 specimens			11.18	81.70	8.58	4.18	0.60	1.76	1.16
Average of 34 specimens			17.61	87.13	12.87	6.04	1.17	3.63	2.03
OYSTERS, "SOLIDS."2									
Fair Haven, Conn	89	Nov., 1881	100.00	85.21	14.79	6.60	1.77	5.60	0.82
Do	204	Mar., 1882	100.00	88.44	11.56	5.91	1.54	3.22	0.89
Do (average of 2 specimens)			100.00	86.82	13.18	6.26	1.66	4.41	0.85
Virginia, transplanted (?)	104	Nov., 1881	100.00	87.27	12.73	6.56	1.54	3.61	1.06
Do	202	Mar., 1882	100.00	87.90	12.10	6.13	1.57	3.63	0.77
Do (average of 2 specimens)			100.00	87.58	12.42	6.34	1.55	3.62	0.91
OYSTERS, CANNED.									
Chesapeake Bay	74		100.00	86.02	13.98	7.96	2.05	2.56	1.41
Do	97		100.00	85.15	14.85	7.29	2.20	4.08	1.28
Do	120		100.00	84.60	15.40	6.97	1.97	5.21	1.25
Do (average of 3 specimens)			100.00	85.26	14.74	7.41	2.07	3.95	1.31

* Taken about 6 months after transplanting to New Haven, Conn.
† About 3 weeks after transplanting to New Haven, Conn.
‡ About 5 weeks after transplanting to New Haven, Conn.
(1) To New Haven, Conn. (2) *I. e.*, shell contents including flesh and liquids as commonly sold.
(3) Not floated. (4) Floated.

TABLE XII.—*Composition of oysters in different months from April*, 1881, *to March*, 1882.

[Percentage of flesh in specimens.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	7.5	7.3	11.0	....	11.2
Fair Haven, Conn	12.6	....	12.3	....	12.2
Norwalk, Conn	....	....	7.6	7.3	......
Blue Point, N. Y	13.4	....	6.5	8.0	......
Rockaway, N. Y	10.7	....	12.1	....	......
Long Island Sound, N. Y	9.1	....	9.0	....	......
East River, N. Y	10.3	....	11.9	....	......
Shrewsbury, N. J	12.6	....	11.3	9.6	......
Potomac River, Va., transplanted*	....	6.5	8.4	....	......
James River, Va., transplanted*	....	6.5	9.5	....	......
Average	9.9		10.2	....	......

[Percentages of liquids in specimens.]

Stony Creek, Conn	11.4	11.8	7.3	....	9.3
Fair Haven, Conn	5.4	....	12.1	....	4.4
Norwalk, Conn	....	....	10.2	9.8	......
Blue Point, N. Y	5.2	....	9.7	7.4	......
Rockaway, N. Y	7.7	....	7.7	....	......
Long Island Sound, N. Y	7.1	....	7.1	....	......
East River, N. Y	10.0	....	8.4	....	......
Shrewsbury, N. J	4.9	....	8.4	9.7	......
Potomac River, Va., transplanted*	....	5.6	7.8	....	......
James River, Va., transplanted*	....	7.3	5.5	....	......
Average	7.2		8.2	....	......

[Percentages of shell contents (flesh and liquid) in specimens.]

Stony Creek, Conn	18.9	19.2	18.2	....	20.5
Fair Haven, Conn	18.1	....	24.3	....	16.6
Norwalk, Conn	....	....	17.9	17.1	......
Blue Point, N. Y	18.6	....	16.2	15.4	......
Rockaway, N. Y	18.4	....	19.8	....	......
Long Island Sound, N. Y	16.2	....	16.1	....	......
East River, N. Y	20.3	....	20.3	....	......
Shrewsbury, N. J	17.5	....	19.7	19.2	......
Potomac River, Va., transplanted*	....	12.2	16.1	....	......
James River, Va., transplanted*	....	13.8	15.0	....	......
Average	17.1		18.4	....	......

[Percentages of water-free substance in the flesh.]

Stony Creek, Conn	19.0	17.9	22.3	....	19.6
Fair Haven, Conn	18.7	....	23.8	....	19.2
Norwalk, Conn	....	....	18.7	19.5	......
Blue Point, N. Y	23.2	....	24.5	16.0	......
Rockaway, N. Y	18.7	....	22.3	....	......
Long Island Sound, N. Y	15.5	....	19.4	....	......
East River, N. Y	20.1	....	24.8	....	......
Shrewsbury, N. J	18.4	....	22.4	18.3	......
Potomac River, Va., transplanted*	....	21.1	22.1	....	......
James River, Va., transplanted*	....	16.5	22.0	....	......
Average	19.0		22.6	....	......

*To New Haven, Conn.; taken in December; in calculating averages below this is omitted; unfloated; average of two specimens.

TABLE XII.—*Composition of oysters in different months*—Continued.

[Percentages of water-free substance in liquids.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	3.9	3.7	4.6	....	4.7
Fair Haven, Conn	6.0	....	5.6	....	4.6
Norwalk, Conn	....	....	3.5	3.7	......
Blue Point, N. Y	5.7	....	3.1	3.1	......
Rockaway, N. Y	4.9	....	5.2	....	......
Long Island Sound, N. Y	3.7	....	4.8	....	......
East River, N. Y	4.6	....	5.1	....	......
Shrewsbury, N. J	4.9	....	4.7	3.5	......
Potomac River, Va., transplanted*	....	4.5	5.0	....	......
James River, Va., transplanted*	....	4.1	5.3	....	......
Average	4.7		4.8	....	......

[Percentages of water-free substance in shell contents.]

Stony Creek, Conn	9.9	9.1	15.2	....	12.8
Fair Haven, Conn	14.9	....	14.7	....	15.3
Norwalk, Conn	....	....	10.0	10.4	......
Blue Point, N. Y	18.3	....	11.7	9.8	......
Rockaway, N. Y	12.9	....	15.7	....	......
Long Island Sound, N. Y	10.3	....	13.1	....	......
East River, N. Y	12.4	....	16.7	....	......
Shrewsbury, N. J	14.6	....	14.8	10.8	......
Potomac River, Va., transplanted*	....	13.4	13.9	....	......
James River, Va., transplanted*	....	10.0	15.9	....	......
Average	12.9		14.6	....	......

[Percentages of water-free substance in whole specimens.]

Stony Creek, Conn	1.9	1.7	2.8	....	2.6
Fair Haven, Conn	2.7	....	3.6	....	2.6
Norwalk, Conn	....	....	1.8	1.8	......
Blue Point, N. Y	3.4	....	1.9	1.5	......
Rockaway, N. Y	2.4	....	3.1	....	......
Long Island Sound, N. Y	1.7	....	2.1	....	......
East River, N. Y	2.5	....	3.4	....	......
Shrewsbury, N. J	2.6	....	2.9	2.1	......
Potomac River, Va., transplanted*	....	1.6	2.2	....	......
James River, Va., transplanted*	....	1.4	2.4	....	......
Average	2.2		2.7	....	......

[Percentages of protein in water-free substance of flesh.]

Stony Creek, Conn	55.1	55.2	47.8	....	53.0
Fair Haven, Conn	52.9	....	46.1	....	51.5
Norwalk, Conn	....	....	51.0	51.1	......
Blue Point, N. Y	44.3	....	54.4	54.9	......
Rockaway, N. Y	49.0	....	47.1	....	......
Long Island Sound, N. Y	52.5	....	51.4	....	......
East River, N. Y	52.0	....	40.6	....	......
Shrewsbury, N. J	44.7	....	43.2	50.1	......
Potomac River, Va., transplanted*	....	46.4	46.6	....	......
James River, Va., transplanted*	....	50.1	48.3	....	......
Average	49.7		47.3	....	......

* To New Haven, Conn.; taken in December; in calculating averages below this is omitted; unfloated; average of two specimens.

TABLE XII.—*Composition of oysters in different months*—Continued.

[Percentages of fats in water-free substance of flesh.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	8.4	8.3	10.4	....	9.4
Fair Haven, Conn	10.9	....	10.4	....	10.7
Norwalk, Conn	....	....	8.1	9.7	......
Blue Point, N. Y	9.9	....	8.3	10.1	......
Rockaway, N. Y	11.3	....	12.2	....	......
Long Island Sound, N. Y	10.8	....	9.4	....	......
East River, N. Y	10.8	....	11.6	....	......
Shrewsbury, N. J	12.0	....	11.9	10.9	
Potomac River, Va., transplanted *	....	10.8	10.6	....	......
James River, Va., transplanted *	....	10.8	11.8	....	......
Average	10.6		10.7	....	......

[Percentages of extractives in water-free substance of flesh.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	21.9	22.2	30.5	....	26.3
Fair Haven, Conn	24.4	....	35.1	....	28.2
Norwalk, Conn	37.6	....	29.7	28.2	......
Blue Point, N. Y	....	....	26.8	25.1	......
Rockaway, N. Y	30.7	....	31.7	......	......
Long Island Sound, N. Y	27.6	....	28.4	....	......
East River, N. Y	28.5	....	40.3	....	......
Shrewsbury, N. J	36.1	....	36.6	29.7	......
Potomac River, Va., transplanted *	......	30.8	33.0	....	......
James River, Va., transplanted *	....	28.7	29.9	....	......
Average	29.6		32.5	......	......

[Percentages of protein in water-free substance of shell contents (flesh and liquids).]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	47.2	46.1	45.6	....	49.2
Fair Haven, Conn	50.7	....	44.7	....	50.5
Norwalk, Conn	....	....	45.2	45.0	......
Blue Point, N. Y	44.0	....	49.6	50.9	......
Rockaway, N. Y	46.5	....	45.4	....	......
Long Island Sound, N. Y	49.9	....	48.9	....	......
East River, N. Y	49.2	....	39.9	....	......
Shrewsbury, N. J	44.4	....	42.8	48.4	......
Potomac River, Va., transplanted *	....	44.2	44.8	....	......
James River, Va., transplanted *	....	45.5	46.9	....	......
Average	46.8		45.4	....	......

[Percentages of fats in water-free substance of shell contents (flesh and liquids).]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	6.5	6.6	9.2	....	8.0
Fair Haven, Conn	9.6		8.5	....	9.9
Norwalk, Conn	....	....	6.5	7.8	......
Blue Point, N. Y	9.2	....	7.0	8.6	......
Rockaway, N. Y	9.6	....	10.6	....	......
Long Island Sound, N. Y	9.6	....	8.0	....	......
East River, N. Y	8.9	....	10.3	....	......
Shrewsbury, N. J	11.0		10.4	9.2	......
Potomac River, Va., transplanted *	....	9.1	8.8	....	......
James River, Va., transplanted *	....	8.5	10.5	....	......
Average	9.1		9.2	....	......

* To New Haven, Conn.; taken in December; in calculating the averages below this is omitted; unfloated; average of two specimens.

TABLE XII.—*Composition of oysters in different months*—Continued.

[Percentages of extractives in water-free substance of shell contents (flesh and liquids).]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	18.5	19.4	21.2	....	24.5
Fair Haven, Conn	22.9	....	31.8	....	27.2
Norwalk, Conn	....	....	26.0	24.7	......
Blue Point, N. Y	36.4	....	24.8	23.8	......
Rockaway, N. Y	29.0	....	29.7	....	......
Long Island Sound, N. Y	29.3	....	25.7	....	......
East River, N. Y	28.5	....	37.4	....	......
Shrewsbury, N. J	34.6	....	33.9	26.7	......
Potomac River, Va., transplanted *	....	28.0	29.7	....	......
James River, Va., transplanted [b]	....	24.3	28.0	....	......
Average	28.0		29.1	....	......

* To New Haven, Conn.; taken in December; in calculating the averages below this is omitted; unfloated; average of two specimens.

TABLE XIII.—*Composition of the flesh of clams, mussels, and scallops.*

[Arranged by percentage of water-free substance in flesh, from highest to lowest.]

Names and localities of specimens.	Laboratory No. of specimen.	Taken from beds.	Flesh in whole specimen.	In flesh. Water.	Water-free substance.	In water-free substance. Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference.)	Ash.
Long clams (Mya arenaria):			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Boston, Mass	67	May, 1881	29.26	77.96	22.04	14.55	1.79	2.94	2.76
Clinton, Conn	102	Nov., 1881	32.89	78.57	21.43	14.86	1.78	2.30	2.49
Do	201	Mar., 1882	39.37	79.94	20.06	12.62	1.69	2.64	3.11
Long Island, N. Y	65	Apr., 1881	36.49	81.05	18.95	12.52	1.52	3.35	1.56
Average of 4 specimens	.....	....	....	79.38	20.62	13.64	1.69	2.81	2.48
Long clams, canned:									
Penobscot Bay, Me	122	....	42.70	74.63	25.37	17.73	2.89	1.59	3.16
Round clams (Venus mercenaria):									
Little Neck, N. Y	66	April, ——	16.80	78.24	21.76	11.59	0.74	7.21	2.22
Round clams, canned:									
Islip, Long Island, N. Y	125	....	50.55	75.56	24.44	16.70	1.27	4.14	2.33
Mussels (Mytilus edulis):									
Stony Creek, Conn	130	December	32.66	78.67	21.33	12.51	1.67	5.42	1.73
Scallops (Pecten irradians):									
Shelter Island, N. Y	51	March	....	77.79	22.21	15.05	0.03	5.65	1.48
Do	63	April	....	82.84	17.16	14.44	0.30	1.13	1.29
Average of 2 specimens	....	....	....	80.32	19.68	14.75	0.17	3.38	1.38

TABLE XIV.—*Composition of liquids of clams and mussels.*

[Arranged by percentage of water-free substance in liquids from highest to lowest.]

Names and localities of specimens.	Laboratory No. of specimen.	Taken from beds.	Liquids in whole specimen.	In liquids.					
				Water.	Water-free substance.	In water-free substance.			
						Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference).	Ash.
Long clams (Mya arenaria):			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Long Island, N. Y	65	Apr., 1881	21.15	94.76	5.24	1.30	0.03	0.98	2.93
Boston, Mass	67	May, 1881	24.64	95.74	4.26	0.49	0.01	0.47	3.29
Clinton, Conn	102	Nov., 1881	25.03	96.02	3.98	0.65	0.00	0.52	2.81
Do	201	Mar., 1882	16.93	96.77	3.23	0.67	0.01	0.50	2.05
Average of 4 specimens	....	... .	......	95.82	4.18	0.78	0.01	0.62	2.77
Long clams, canned:									
Penobscot Bay, Maine	122	....	57.30	91.92	8.08	2.49	0.04	3.83	1.72
Round clams (Venus mercenaria):									
Little Neck, N. Y	66	Apr., ——	14.91	95.12	4.88	0.90	0.02	0.79	3.17
Round clams, canned:									
Islip, Long Island, N. Y	125	....	49.45	90.52	9.48	4.07	0.26	1.89	3.26
Mussels (Mytilus edulis):									
Stony Creek, Conn	139	Dec., ——	18.00	94.23	5.77	1.77	0.13	1.64	2.23

TABLE XV.—*Composition of shell contents of clams, mussels, and scallops.*

Names and localities of specimens.	Specimen No.	Taken from beds.	Shell contents in whole specimen.	In shell contents.					
				Water.	Water-free substance.	In water-free substance.			
						Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference).	Ash.
Long clams (Mya arenaria):			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Clinton, Conn	201	Mar., 1882	56.30	85.00	15.00	9.03	1.19	1.99	2.79
Boston, Mass	67	May, 1881	53.90	86.09	13.91	8.12	0.98	1.81	3.00
Long Island, N. Y	65	Apr., 1881	57.64	86.10	13.90	8.39	0.97	2.48	2.06
Clinton, Conn	102	Nov., 1881	57.92	86.11	13.89	8.71	1.01	1.54	2.63
Average of 4 specimens	....	....	56.44	85.82	14.18	8.56	1.04	1.96	2.62
Long clams, canned:									
Penobscot Bay, Me	122	....	100.00	84.54	15.46	9.00	1.26	2.86	2.34
Round clams (Venus mercenaria):									
Little Neck, N. Y	66	Apr., 1881	31.71	86.18	13.82	6.52	0.40	4.24	2.66
Round clams, canned:									
Islip, Long Island, N. Y	125	....	100.00	82.96	17.04	10.45	0.77	3.03	2.79
Mussels (Mytilus edulis):									
Stony Creek, Conn	139	Dec., 1881	50.66	84.20	15.80	8.69	1.12	4.08	1.91
Scallops (Pecten irradians):									
Shelter Island, N. Y	51	Mar., 1881	100.00*	77.79	22.21	15.05	0.03	5.65	1.48
Do	63	Apr., 1881	100.00*	82.84	17.16	14.44	0.30	1.13	1.29
Average of 2 specimens	....	....	......	80.32	19.68	14.75	0.17	3.38	1.38

* The adductor muscle, the portion ordinarily eaten.

TABLE XVI.—*Composition of flesh (edible portion) of crustaceans and turtles.*

Names and localities of specimens.	Laboratory No. of specimen.	Specimen received.	In water-free substance.					
			Nitrogen.	Protein (N × 6.25).	Fats (ether extract.)	Ash.	Protein, fats, and ash.	Albuminoids (by difference).
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Lobster (Homarus americanus):								
Maine	50	Mar., 1881	1.86	11.63	1.82	1.63	15.08	12.25
Do	62	Apr., 1881	2.24	14.05	1.55	1.71	17.31	14.97
Do	239	Apr., 1882	2.76	17.24	1.45	1.62	20.31	17.76
Massachusetts	69	May, 1881	2.41	15.03	2.54	1.87	19.44	13.48
Average of 4 specimens			2.32	14.49	1.84	1.71	18.04	14.62
Lobster, canned:								
Maine	76		2.68	16.75	0.46	2.78	19.99	17.40
Do	121		3.12	19.52	1.68	2.15	23.35	20.02
Average of 2 specimens			2.90	18.13	1.07	2.47	21.67	18.71
Crayfish:								
Potomac River, Va	64	Apr., 1881	2.56	16.00	0.46	1.31	17.77	17.01
Crab (Callinectes hastatus):								
New Jersey	101	Nov., 1881	2.66	16.64	1.96	3.13	21.73	17.84
Crab, canned:								
Hampton, Va	124		2.50	15.62	0.79	1.78	18.19	16.45
Do	274		2.56	15.98	2.30	2.10	20.38	16.65
Average of 2 specimens			2.53	15.80	1.55	1.94	19.29	16.55
Shrimp, canned:								
Gulf of Mexico	123		4.06	25.38	1.00	2.58	28.96	25.62
Terrapin:								
Savannah, Ga	235	Apr., 1882	3.40	21.23	3.47	1.02	25.72	21.04
Green turtle (Chelonia mydas):								
Key West, Fla	272	May, 1882	3.17	19.84	0.53	1.20	21.57	18.49

4. FLOATING OF OYSTERS.*

Not every lover of the oyster knows that the size and plumpness which are so highly prized in the great American bivalve, and which are so attractive in specimens on the half-shell or in the stew as to lead the average man to pay a considerable extra price for extra size, are not entirely natural; and even those who do know that the majority of the oysters in the market are artificially swollen by introducing water into the tissues are not all aware that the process by which this is done is closely analogous to that by which the food in our bodies is conveyed through the walls of the stomach and other parts of the digestive apparatus and poured into the blood and lymph to do its work of nourishment.

Physiologists are, I believe, agreed that the passage of the digested food through the walls of the alimentary canal in man and other animals is, in large part, due to osmose or dialysis, and that the operation of this physical law is a very common one in the animal body. But the quantitative study of the chemical changes involved is generally rendered difficult or impossible by the very fact of their taking place in living animals where the application of chemical analysis is impossible; an opportunity is, however, offered by the oyster, which, since it lives in water and has a body so constituted as to readily permit the inflow and outflow of water and solutions of salts, may be easily used for

* The substance of this chapter was printed in the Report of the Oyster Investigation and Shellfish Commission of New York, for 1887.

experiments. The results of the experiments have a practical as well as scientific interest, since they confirm the common explanation of the increase in bulk of oysters by "floating," and show that it is essentially a process of watering in which the bulk is increased without any corresponding increase, but rather, if anything, a loss of nutritive material.

It is a common practice of oyster dealers, instead of selling the oysters in the condition in which they are taken from the beds in salt water, to first place them for a time—48 hours, more or less—in fresh or brackish water, in order, as the oyster men say, to "fatten" them, the operation being called "floating" or "laying out." By this process the body of the oyster acquires such a plumpness and rotundity, and its bulk and weight are so increased, as to materially increase its selling value.

The belief is common among oystermen that this "fattening" is due to an actual gain of flesh and fat, and that the nutritive value of the oyster is increased by the process. A moment's consideration of the chemistry and physiology of the subject will make it clear, not only that such an increase of tissue substance in so short a time and with such scanty food supply is out of the question, but that the increase of volume and weight of the bodies of the oysters is just what would be expected from the osmose which would naturally take place between the contents of the bodies of the oysters as taken from salt water and the fresh or brackish water in which they are floated.

If we fill a bladder with salt water and then put it into fresh water, the salt water will gradually work its way out through the pores of the bladder, and at the same time the fresher water will enter the bladder; and, further, the fresh water will go in much more rapidly than the salt water goes out. The result will be that the amount of water in the bladder will be increased. The bladder will swell by taking up more water than it loses, while at the same time it loses a portion of the salt. It does this in obedience to a physical law, to which the terms osmose and dialysis are applied. In accordance with this law, if a membranous sac holding salts in solution is immersed in a more dilute solution or in pure water, the more concentrated solution will pass out, and at the same time the water, or more dilute solution, will pass in, and more rapidly. The escape of the concentrated and entrance of the dilute solution will be, in general, the more rapid the greater the difference in concentration and the higher the temperature of the two solutions. After the osmose has proceeded for a time the two solutions will become equally diluted. When this equilibrium between the two is reached the osmose will stop. If the sac which has become distended is elastic, it will, after osmose has ceased, tend to come back to its normal size, the extra quantity of solution which it has received being driven out again.

We should expect these principles to apply to the oyster. Roughly speaking, the body of the animal may be regarded as a collection of membranous sacs. It seems entirely reasonable to suppose that the intercellular spaces, and probably the cells of the body, would be im-

pregnated with the salts of the sea water in which the animal lives; and this supposition is confirmed by the large quantity of mineral salt which the body is found by analysis to contain, and which amounts in some cases to over 14 per cent. of the water-free substance of the body.

It seems equally reasonable to believe that osmose would take place through both the outer coating of the body and the cell walls of the animal's body. As long as the oyster stays in the salt water the solution of salts within its body would naturally be in equilibrium with the water outside. When the animal is brought into fresh or brackish water—*i. e.*, into a more dilute solution—we should expect the salts in the more concentrated solution within its body to pass out, and a larger amount of fresh water to enter, and produce just such a distension as actually takes place in the floating. If this assumption is correct, we should expect that the osmose would be the more rapid the less the amount of salts in the surrounding water; that it would proceed more rapidly in warm and more slowly in cold water; that it would take place whether the body of the animal is left in the shell or is previously removed from it; that the quantity of salts would be greatly reduced in floating; and that, if it were left in the water after the maximum distension had been reached, the imbibed water would pass out again and the oyster would be reduced to its original size. Just such is actually the case. Oystermen find that the oysters "fatten" much more quickly in fresh than in brackish water; warmth is so favorable to the process that it is said to be sometimes found profitable to warm artificially the water in which the oysters are floated. Although oysters are generally floated in the shell, the same effect is very commonly obtained by adding fresh water to the oysters after they have been taken out of the shell; indeed, I am told that this is by no means an unusual practice of retail dealers. Oysters lose much of their salty flavor in floating and it is a common experience of oystermen that if the "fattened" oysters are left too long on the floats they become "lean" again.

This exact agreement of theory and fact might seem to warrant the conclusion that the actual changes in the so-called fattening of oysters in floating are essentially gain of water and loss of salts. The absolute proof, however, is to be sought in chemical analysis. In the course of the investigations which have been described on the preceding pages I improved the opportunity to test this matter by some analyses of oysters before and after floating. I give here the main results, prefacing by brief accounts of the process of "floating" oysters as actually practiced by oystermen.

The following very apposite statements* are by Prof. Persifor Frazer, jr., who attributes the changes mentioned to dialytic action:

The oysters brought to our large markets on the Atlantic seaboard are generally first subjected to a process of "laying out," which consists in placing them for a short time in fresher water than that from which they have been taken.

* "Note on Dialysis in Oyster Culture," in "Proceedings of Philadelphia Academy of Sciences," 1875, p. 472.

Persons who are fond of this animal as an article of food know how much the "fresh" exceed the "salts" in size and consistency. The "Morris Coves" of this city (Philadelphia), while very insipid, are the plumpest bivalves brought to market. On the other hand, the "Absecoms" and "Brigantines," while of a better flavor (to those who prefer salt oysters), are invariably lean compared to their transplanted rivals, as also are the "Cape Mays," though for some reason not to the same extent.

The most experienced oyster dealers inform me that the time for allowing the salt oysters taken from the seacoast to lie out varies, but is seldom over 2 or 3 days. At the end of this time the maximum plumpness is attained, and beyond this the oyster becomes lean again, besides having lost in flavor.

The subjoined statements by Prof. John A. Ryder are interesting in this connection. They are taken from a letter to Professor Baird on "Floats for the so-called Fattening of Oysters:"*

The simplest and most practical structures of the kind which I have seen are the storage and fattening floats used by Mr. Conger, of Franklin City, Maryland, and now in use by all the shippers and planters in the vicinity of Chincoteague Bay. I have been informed that similar structures, or rather structures serving similar purposes, are in use on the oyster beds along the shore of Staten Island, New York.

It is probably a fact that in all these contrivances they take advantage of the effect produced by fresher water upon oysters which have been taken from slightly salter water. The planters of Chincoteague call this "plumping the oysters for market." It does not mean that the oysters are augmented in volume by the addition of substantial matter, such as occurs during the actual appropriation of food, but only that the vascular spaces and vessels in the animals are filled with a larger relative amount of water due to endosmose. It is a dealer's trick to give his produce a better appearance in the market, and as such I do not think it deserves encouragement, but rather exposure.

Mr. Conger has actually resorted to warming fresh water to 60 F. in winter by steam pipes running underneath the wooden inclosure surrounding the "fattening" or "plumping" float. One good "drink," as he expressed himself to me, renders the animals fit for sale and of better appearance.

Conger's floats are simply a pair of windlasses, supported by two pairs of piles driven into the bottom. Chains or ropes, which wind upon the windlasses, pass down to a pair of cross-pieces, upon which the float rests, which has a perforated or strong slat bottom and a rim 18 inches to 2 feet high. These floats I should think are about 8 feet wide, and 16 feet long, perhaps 20. These structures are usually built alongside the wharves of the packing and shipping houses, and are really a great convenience in conducting the work.

Elsewhere Professor Ryder speaks of the floats thus:

The diaphragm itself was constructed of boards perforated with auger holes, and lined on the inside with gunny cloth or sacking, and the space between the perforated boards was filled with sharp, clean sand. This space between the boards was about 2 inches; through this the tide ebbed and flowed, giving a rise and fall of from 4 to 6 inches during the interval between successive tides.

Mr. F. T. Lane, of New Haven, Connecticut, writes as follows about the method of floating practiced by himself, and, as I understand, by other New Haven oyster-growers:

We do not always leave them 2 days in the floats; as a rule only 1 day. We put them into brackish water and take them out at low water or in the last of the falling tide, and then the water is the freshest and the oysters are at their best. As it is not convenient for us to put them into the floats and take them out the same day, we do

* Bulletin, U. S. Fish Commission, 1884, p. 302.

not want the water too fresh. On one occasion, wishing to know what the result would be of putting the oysters into water that was quite fresh, I had one of my floats taken up the river half a mile farther than where we commonly use them, and 100 bushels of oysters put into it at high water and taken out at low water. They were in the water from 6 to 7 hours, and came out very nice, fully as good as those floated 24 hours in the brackish water. It was a warm day, and the water was warm. Under these conditions they will drink very quickly. I have seen them open their shells in 10 minutes after they were put into the water.

For the following valuable information I am indebted to Mr. R. G. Pike, chairman of the board of shellfish commissioners of Connecticut:

Connecticut oysters, when brought from their beds in the salt waters of Long Island Sound, are seldom sent to market before they have been subjected to more or less manipulation. As soon as possible after being gathered, they are deposited in shallow tide rivers where the water is more or less brackish, and are left there from 1 to 4 days, the time varying according to the temperature of the season, the saltness of the oysters, and the freshening quality of the water. Generally two tides are sufficient for the two "good drinks" which the oystermen say they should always have.

This "floating," as it is called, results in cleaning out and freshening the oysters, and increasing their bulk; or, as many oystermen confidently assert, "fattening" them. If the weather is warm, they will "take a drink" immediately if not disturbed; but if the weather is cold, they will wait sometimes 10 or 12 hours before opening their valves. Good fat oysters generally yield 5 quarts of solid meat to the bushel; but after floating two tides or more, they will measure 6 quarts to the bushel. After they have been properly floated, they are taken from the shell, and as soon as the liquor is all strained off, they are washed in cold fresh water, and are then packed for market. In warm weather they are put into the water with ice, and are also packed with ice for shipping. Water increases their bulk by absorption and by mixing with the liquor on the surface of the oysters. The salter the oyster the more water it absorbs. In 12 hours 1 gallon of oysters with their juices strained out will take in a pint of water, but when very salt or dry, they have been known to absorb a pint in 3 hours.

Water always thickens the natural juices that adhere to the surface of the oyster, and makes them slimy. If too much water is added, the oyster loses its plumpness and firmness and becomes watery and flabby.

Oysters that have been floated bear transportation in the shell much better than when shipped directly from their beds. Oysters, too, that are taken from their shells and packed in all their native juices spoil much sooner than when their juices are strained out and the meats are washed in fresh cold water.

Long clams are not floated, but round clams are; but both, when shucked, are washed in fresh water; this cleanses them of mud, sand, and excess of salt, increases their bulk, and improves their flavor. After washing, they will keep much longer without risk of spoiling. If the salt is left in them, as they come from their native beds, their liquor will ferment and they will quickly spoil.

The above facts are gathered from the most intelligent men in the shellfish business in Connecticut—men who have had many years' experience in gathering oysters and clams and preparing them for home and foreign consumption. They are all agreed that by judicious floating in the shell, and by washing and soaking when out of the shell, the oyster and the clam increase in bulk and improve in quality and flavor. We will not presume to say that this increased bulk is anything more than a mechanical distention of the organs and the cellular tissues of the oyster by the water; or that its improved flavor is not due simply to a loss of bitter sea-salt dissolved out by the water. Many intelligent cultivators are confident that the increase in bulk is a growth of fat; while just as many, of equal intelligence, declare that it is mere "bloat" or distention, akin to that of a dry sponge when plunged into the water. The exact nature of the change the chemist alone can determine.

Experiments were made with oysters supplied by Mr. Lane, of New Haven, Conn., the details of which are given in Part I, section D. The oysters had been brought from the James and Potomac Rivers, and "planted" in the beds in New Haven Harbor (Long Island Sound) in April, and were taken for analysis in the following November.

Two experiments were made. The plan of each experiment consisted in analyzing two lots of oysters, of which both had been taken from the same bed at the same time, but one had been "floated" while the other had not. For each of the two experiments, Mr. Lane selected from a boatload of oysters, as they were taken from the salt water, a number, about three dozen, which fairly represented the whole boatload. The remainder were taken to the brackish water of a stream emptying into the bay and kept upon the floats for 48 hours, this being the usual practice in the floating of oysters in this region. At the end of that time, the oysters were taken from the floats, and a number fairly representing the whole were selected as before. Two lots, one floated and the other not floated, were thus taken from each of two different beds. The four lots were brought to our laboratory for analysis.

The principal results of the experiments described in Part I, Section D, and the inferences to be derived from them, may be briefly summarized as follows:

RECAPITULATION OF RESULTS OF THE EXPERIMENTS.

It will be remembered that the comparison was made between oysters analyzed in the condition in which they came from the beds in salt water and those which, taken from the same beds at the same time, had been "floated," *i. e.*, kept for a time (in this case 48 hours) in brackish water, as is commonly done in preparing them for the market on the Atlantic coast of the United States. The methods employed for this purpose, of course, vary widely in different localities and times, so that these results can not be taken as an exact measure of the practical effect except in this particular case. At the same time it is noticeable that the results in these experiments seem to agree very well (so far as the increase of weight is concerned, at any rate) with those of ordinary practice.

During the sojourn in brackish water both the flesh (body) and the liquid portion of the shell contents of the oysters suffered more or less alteration in composition.

CHANGES IN THE FLESH.

1. The changes in the constituents of the body were mainly such as would be caused by osmose (dialysis), though there were indications of secretion of nitrogenous matters, and especially of fats, which are not so easily explained by osmose.

2. The amount of gain and loss of constituents, which the bodies of

the oysters experienced, may be estimated either by comparing the percentages found by analysis before and after dialysis or by comparing the absolute weight of a given quantity of flesh and the weights of each of its ingredients before with the weights of the same flesh and of its ingredients after dialysis. For the estimate by the first method we have simply to compare the results of the analyses of the floated and the not-floated specimens. Taking the averages of the two experiments, it appears that:

The percentages of—	Before dialysis.		After dialysis.
Water rose from	77.9	to	82.4
Water-free substance fell from	22.1	to	17.6
	100.0		100.0
Protein (N × 6.25) fell from	10.5	to	8.9
Fat (ether extract) fell from	2.5	to	1.9
Carbohydrates, etc., fell from	6.9	to	5.2
Mineral salts (ash) fell from	2.2	to	1.6
	22.1		17.6

There was, accordingly, a gain in the percentage of water and a loss in that of each of the ingredients of the water-free substance.

It is more to the point to note the actual increase and decrease in amounts of flesh and its constituents, the absolute gain or loss of each in the floating. The estimates (see table, page 812) make it appear that 100 grammes of the flesh as it came from the salt water was increased by floating, in one specimen, to 120.9, and in the other to 113.4 grammes. This is equivalent to saying that the two specimens of flesh gained in the floating, respectively, 20.9 and 13.4 per cent., or, on the average, 17.3 per cent. of their original weight. By the same estimates the water-free substance in the 100 grammes of flesh before the floating weighed, on the average, 22.1 grammes, while that of the same flesh after dialysis weighed only 20.6 grammes, making a loss of 1.5 grammes or 6.6 per cent. of the 22.1 grammes which the water-free substance weighed before dialysis. The main results of the two experiments thus computed, may be stated as follows:

In the "floating" of 100 grammes of flesh (body) of the oysters:

The weight (in grammes) of—	Before dialysis.		After dialysis.
Water rose from	77.9	to	96.6
Water-free substance fell from	22.1	to	20.6
Whole flesh rose from	100.0	to	117.2
Protein was assumed to remain the same	10.5	to	10.5
Fat (ether extract) fell from	2.5	to	2.3
Carbohydrates, etc., fell from	6.9	to	6.0
Mineral salts (ash) fell from	2.2	to	1.8
	22.1	to	20.6

Estimating the increase or decrease of weight of each constituent in per cent. of its weight before floating, the water gained 23.9 per cent.; the water-free substance lost 6.6 per cent.; the whole flesh (body) gained 17.3 per cent. The protein was assumed to neither gain nor lose. The fat lost 8.8 per cent.; the carbohydrates, etc., lost 12.5 per cent.; the mineral salts lost 15.5 per cent.

According to these computations the flesh lost between one-sixth and one-seventh of its mineral salts, one-eighth of its carbohydrates, and one-twelfth of its fats, but gained enough water to make up this loss and to increase its whole weight by from one seventh to one-fifth.

These estimates are based on the assumption that the amount of protein (N × 6.25) in the flesh remained unchanged during the floating. It seems probable, however, that the flesh may have lost a small amount of nitrogenous material. If this was the case the actual gain of flesh and of water must have been less and the loss of fats, carbohydrates, and mineral salts greater than the estimate makes them. But there appears to be every reason to believe that the error must be very small, and since it would affect all the ingredients in the same ratio, the main result, namely, that there was a large gain of water and a considerable loss not only of mineral salts but of fats and carbohydrates as well, can not be questioned.

CHANGES IN THE COMPOSITION OF THE LIQUID PORTION.

3. The liquids might be expected to receive material from the flesh and to yield material to the surrounding water. The materials received from the flesh would be such as the latter parted with by osmose or secretion. Those yielded to the water would either escape by diffusion or be washed away when the shells were open wide enough. Comparing the percentage composition of the liquids before and after floating, as shown by the averages of the analyses in the two experiments, it appears that:

The percentages of—	Before dialysis.		After dialysis.
Water rose from	94.9	to	95.5
Water-free substance fell from	5.1	to	4.5
	100.0		100.0
Protein (N × 6.25) rose	1.9	to	2.1
Carbohydrates, etc., rose	0.7	to	1.1
Mineral salts, (ash) fell	2.5	to	1.3

The increase in the percentage of water and the decrease in that of mineral salts are very marked. The quantities of fats (ether extract) are too small to be taken into account. The increase of nitrogen and that of carbohydrates, though absolutely small, are nevertheless outside the limits of error of analysis, and must, like those of the salts, represent actual changes in the composition of the liquids.

The experiments give no reliable data for the determinations of the absolute increase and decrease of the liquids and their constituents, so that it is impossible to say with entire certainty whether there was or was not an actual gain of protein or fats or carbohydrates. It seems very probable, however, that the liquids received and retained small quantities of these materials from the flesh (bodies) of the animals.

CHANGES IN THE COMPOSITION OF THE WHOLE SHELL CONTENTS, FLESH AND LIQUIDS.

4. Comparing the average percentage composition of the total shell contents before and after floating in the two experiments, it appears:

The percentages of—	Before dialysis.		After dialysis.
Water rose from	85.2	to	87.1
Water-free substance fell from	14.8	to	12.9
	100.0		100.0
Protein (N × 6.25) fell from	6.8	to	6.5
Fats (ether extract) fell from	1.4	to	1.2
Carbohydrates, etc., fell from	4.3	to	3.7
Mineral salts (ash) fell from	2.3	to	1.5
	14.8		12.9

The changes in the total shell contents are mainly those of the flesh, since the amounts of the organic and mineral ingredients of the liquids are small. The water-free substance of the liquids makes only a small part of the whole water-free substance and consists very largely of mineral salts, a large part of which are the salts of the sea water. Here accordingly, as in the flesh, we have to do mainly with an increase of water and decrease of water-free substance and of its ingredients, though there was more loss of protein, carbohydrates, and fats than the gain in the water should account for.

5. The absolute gain and loss of material in the total shell contents can not be exactly computed from the data of these experiments; but it is safe to say that it consists almost entirely in a gain of water and loss of salts, and that, though there seems to be a loss of fats, and especially of carbohydrates, and perhaps a loss of protein also, the amount of these latter that escape during the floating must have been small.

CHANGES DUE TO OSMOSE.

6. From the standpoint of the physiological chemist the chief interest of the experiments is in the quantitative indication of the changes due to dialysis. As was to be expected, the change in composition during the dialysis consisted chiefly in a small loss of soluble materials, especially mineral salts, with some carbohydrates, and a large gain of water. But the flesh (body) of the animals, in which the chief change occurred, appeared to lose a little fat and protein also, which would hardly be taken out by osmose. Their removal is easily explained by assuming processes of secretion or excretion to accompany that of dialysis.

The absorption of digested matters through the walls of the alimentary canal in man and other animals is explained as the joint effect of dialysis and of a special action of the organs through which the materials pass. Considering the body of the oyster as a membranous sac (or as a congeries of membranous sacs) containing a more concentrated solution and immersed in a more dilute solution, and at the same time as a living organism performing its normal functions, the occurrence of physical dialysis along with the physiological processes of secretion or excretion would be perfectly natural.

But although the experiments do not show just how much of the loss of organic compounds was due to purely physical and how much to physiological agencies, it is evident that a large quantity of water was carried into the bodies of the animals and a considerable amount of mineral salts was removed by dialysis.

EFFECT OF FLOATING UPON NUTRITIVE VALUE.

7. So far as the effect of floating upon the nutritive value of the oyster is concerned, the experiments confirm in detail the perfectly evident *a priori* conclusion that with the increase in bulk and weight there is no corresponding gain but rather a slight loss of nutrients. Hence a given weight or volume of floated oysters will have considerably less nutritive material than the same quantity of oysters which have not been thus treated. According to these experiments, which agree with the results of practical experience, the difference would amount to from one-eighth to one-fifth or more in favor of the oysters in their natural condition. But the removal of the salts in floating would be considered by many consumers to improve the flavor of the oysters more than enough to make up for the inferiority in nutritive value. It seems also to be a matter of common experience that oysters keep better when part of the salts have been removed by the dialysis. While, therefore, this treatment of oysters is a device practiced by both cultivators who float and retail dealers who water them and thus increase the bulk of wares sold by bulk, it is not entirely a fraud, since both the flavor and keeping quality are often improved thereby.

5. OYSTERS AS FOOD.

Very little is popularly known, and widely varying views are held with reference to the value of oysters and other shellfish for food. Although a great deal of scientific research has of late been given to the subject of food and nutrition, these particular kinds of food have been studied but little, and what has been done is slow in getting into print and becoming generally known. The lack of popular knowledge of the subject is therefore easy to understand.

Speaking roughly, a quart of oysters contains, on the average, about the same quantity of actual nutritive substance as a quart of milk, or a pound of very lean beef, or a pound and a half of fresh codfish, or two-thirds of a pound of bread. But while the weight of actual nutriment in the different quantities of food materials named is very nearly the same, the quality is widely different. That of the very lean meat or codfish consists mostly of what are called in chemical language protein compounds or "flesh-formers," the substances which make blood, muscle, tendon, bone, brain, and other nitrogenous tissues. That of the bread contains but little of these, and consists chiefly of starch, with a little fat and other compounds which serve the body as fuel and supply it with heat and muscular power. The nutritive substance of oysters contains considerable of both the "flesh-forming" and the more especially heat-and-force giving ingredients. Oysters come nearer to milk than almost any other common food material as regards both the amounts and the relative proportions of nutrients, and the food values of equal weights of milk and oysters, *i. e.*, their values for supplying the body with material to build up its parts, repair its wastes, and furnish it with heat and energy, would be pretty nearly the same. But while this statement is reasonably correct, the studies thus far made are not sufficient to assure us of its absolute accuracy.

The differences which oystermen observe in the quality of oysters from different localities, of different age, and grown under different conditions, are made clearer and are to a considerable extent explained by chemical analysis. Taking the oysters in the shell, the proportion of shell contents, "meat" and "liquor" together, increases relatively to the whole weight as the animal grows, at least up to a certain limit. In other words a bushel of mature oysters will "open" more quarts than a bushel of the very young animals. But the differences between different kinds, or between specimens of the same kind under different conditions, are very wide.

Taking the edible portion of the oyster, after it has been removed from the shell, the differences are much greater than people commonly suppose. This is apparent when we compare either the flesh (meats) or liquids (liquor) of different specimens, or the whole edible portion, the meat and liquor (solids) together. The percentage of water in the edible portion of the different specimens of oysters reported in the tables beyond varied from 83.4 to 91.4 per cent., and averaged 87.3 per cent. This makes the amounts of "water-free substances," *i. e.*, actually nutritive ingredients, vary from 16.6 to 8.6, and average 12.7 per cent. of the whole weight of the edible portion (shell contents) of the animals. In other words the contents of nutritive material in a quart (2 pounds) of shell contents (solids) varied from 2¾ to 5¼ ounces. The proportion of nutritive substance was twice as large in the one case as in the other.

The specimens, as received for analysis, were generally in the shell; on arrival at the laboratory they were weighed; the shell contents were then taken out and separated into flesh (meat) and liquid (liquor); each was weighed separately, as were the shells. From these weights the percentages were calculated. Table XVII gives the results:

TABLE XVII.—*Proportion of flesh, liquids, and shells in specimens of shellfish.*

Kinds of shellfish, locality, season.	Edible portion. Flesh.	Edible portion. Liquids.	Edible portion. Total.	Refuse: shells, etc.
Oysters:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Stony Creek, April	7.5	11.4	18.9	81.1
Stony Creek, November	11.0	7.3	18.3	81.7
Stony Creek, March	11.2	9.3	20.5	79.5
Fair Haven, April	12.6	5.4	18.0	82.0
Fair Haven, November	12.3	12.1	24.4	75.6
Fair Haven, March	12.2	4.4	16.6	83.4
Blue Points, April	13.4	5.2	18.6	81.4
Blue Points, November	6.5	9.7	16.2	83.8
Blue Points, February	8.0	7.4	15.4	84.6
Shrewsbury, April	12.6	4.9	17.5	82.5
Shrewsbury, November	11.3	8.4	19.7	80.3
Shrewsbury, February	9.6	9.7	19.3	80.7
Potomac River, 3 weeks after transplanting*	6.5	5.6	12.1	87.9
Potomac River, 6 months after transplanting*	10.2	6.5	16.7	83.3
James River, 5 weeks after transplanting *	6.5	7.3	13.8	86.2
James River, 6 months after transplanting *	11.4	5.8	17.2	82.8
Specimen with maximum percentage of flesh	13.4	5.2	18.6	81.4
Specimen with maximum percentage of liquids	11.7	13.2	24.9	75.1
Specimen with maximum percentage of shells	4.7	6.5	11.2	88.8
Average of 34 specimens	9.8	7.9	17.7	82.3
Long clams:				
Specimen with maximum percentage of flesh	39.4	16.9	56.3	43.7
Specimen with maximum percentage of liquids	32.9	25.0	57.9	42.1
Specimen with maximum percentage of shells	29.3	24.6	53.9	46.1
Average of 4 specimens	34.5	21.9	56.4	43.6
Round clams	16.8	14.9	31.7	68.3
Mussels	32.7	18.0	50.7	49.3

* To New Haven Harbor.

Thus in the case of the specimen from Stony Creek, taken in April, the shells made 81.1 per cent., or a little over four-fifths; and the edible portion, flesh and liquids together, 19.9 per cent., or a little less than one-fifth of the whole weight. Of this 19.9 per cent., the flesh constituted 7.5 and the liquids 11.4 per cent. In this specimen the proportion of flesh was very small as compared with the liquids. In the specimen of Blue Points, taken at the same time, the proportion of flesh to liquids is just the other way, that of flesh being 13.4 and the liquids 5.2. The variations in the proportions of flesh, liquids, total edible portion, and shells are very striking.

We should not be warranted in assuming that the Blue Points generally have so much more flesh and liquid than the others. The figures of Table XVII are taken from a larger number obtained in a series of analysis of specimens from different localities on the Atlantic coast, from Massachusetts to New Jersey. One object of the investigation was to get light upon the effect of kind, locality, season, and other conditions upon the composition. But though the number of analyses was considerable, enough to cost a large amount of labor, the result can be taken only as a general indication of the range of variation and not as

showing the characteristic composition of specimens of a given source or at a given time. To find, for instance, the average composition of oysters from a given locality, and the differences in composition in different seasons of the year and in different years, would require an investigation to extend through a year or several years, and to include a large number of analyses of specimens especially gathered for the purpose.

The variations in the proportions of flesh, liquids, and shell are so clearly shown in Table XVII that further explanation is hardly necessary.

The details of the proportion of flesh, liquids, and shells and of the composition of the flesh, liquids, and whole edible portion are given in Table XIX, which includes all the specimens analyzed. Table XVIII recapitulates the composition of the edible portion of a number of specimens of oysters, clams, and mussels. It is interesting to note the variations in the composition of the oysters in this table. The percentages of water range from 84.8 to 90.1 per cent. in the specimens here cited. In one of those not here given, but included in Table IV, the percentage of water rose to 91.5. The percentage of water-free substance, *i. e.*, total nutrients, in each case, is the difference between the percentage of water and 100. The nutrients accordingly range from 18.3 to 8.5 per cent. In other words, the proportion of nutritive material was more than twice as large in some cases as in others. The largest proportion of nutrients was in a specimen of Blue Points, taken in April; the smallest is in one from Norfolk, Va., also taken in April.

TABLE XVIII.—*Proportions of water and nutritive ingredients in edible portion of specimens of shellfish from different localities and at different times.*

Kind, locality, and time.	Water.	Nutrients.	Nutrients.			
			Protein.	Fats.	Carbohydrates.	Mineral matters.
Oysters:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Stony Creek, April	90.1	9.9	4.6	0.6	2.0	2.7
Stony Creek, November	84.8	15.2	6.9	1.4	4.5	2.4
Stony Creek, March	87.2	12.8	6.3	1.0	3.2	2.3
Fair Haven, April	85.1	14.9	7.5	1.4	3.5	2.5
Fair Haven, November	85.3	14.7	6.2	1.3	5.0	2.2
Fair Haven, March	84.6	15.4	7.7	1.3	3.5	2.9
Blue Points, April	81.7	18.3	8.2	1.7	6.5	1.9
Blue Points, November	88.3	11.7	5.8	0.8	2.9	2.2
Blue Points, February	90.2	9.8	5.0	0.9	2.3	1.6
Shrewsbury, April	85.4	14.6	6.5	1.6	5.0	1.5
Shrewsbury, November	89.2	10.8	4.9	1.0	3.2	1.7
Shrewsbury, February	85.2	14.8	6.2	1.5	5.2	1.9
Potomac River, 3 weeks after transplanting*	86.6	13.4	5.9	1.2	3.8	2.5
Potomac River, 6 months after transplanting*	87.4	12.6	6.3	1.2	3.7	1.4
James River, 5 weeks after transplanting*	90.1	9.9	4.6	0.8	2.3	2.2
James River, 6 months after transplanting*	87.0	13.0	8.0	1.3	2.2	1.5
Specimen with maximum of nutrients	81.7	18.3	8.2	1.7	6.5	1.9
Specimen with minimum of nutrients	91.5	8.5	4.5	0.6	1.7	1.7
Average of 34 specimens	87.3	12.7	5.9	1.2	3.6	2.0
Long clams:						
Specimen with maximum of nutrients	85.0	15.0	7.6	1.2	3.4	2.8
Specimen with minimum of nutrients	86.1	13.9	8.4	1.0	2.4	2.1
Average of four specimens	85.9	14.1	8.2	1.0	2.3	2.6
Round clams	86.2	13.8	6.6	0.4	4.1	2.7
Mussels	84.2	15.3	8.7	1.1	4.1	1.9

* To New Haven Harbor.

TABLE XIX.—*Percentages of water and nutritive ingredients in specimens of American invertebrates used for food.*

Name and locality of specimen.	Laboratory No. of specimen.	Specimen received.	Edible portion. In flesh. Water.	Edible portion. In flesh. Protein. Nitrogen × 6.25.	Edible portion. In flesh. Fat. Ether extract.	Edible portion. In flesh. Ash.	Edible portion. In liquids. Water.	Edible portion. In liquids. Protein. Nitrogen × 6.25.	Edible portion. In liquids. Fat. Ether extract.	Edible portion. In liquids. Ash.	In edible portion. (Flesh plus liquids.) Water.	In edible portion. (Flesh plus liquids.) Water-free substance.	In edible portion. (Flesh plus liquids.) Protein, Nitrogen × 6.25.	In edible portion. (Flesh plus liquids.) Fat. Ether extract.	In edible portion. (Flesh plus liquids.) Ash.	In edible portion. (Flesh plus liquids.) Carbohydrates.	In whole sample.* Total edible portion.	In whole sample.* Total water-free substance, actual nutrients.
Oysters, (Ostrea virginica) in shell:			P. ct.	P. ct	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Buzzard's Bay, Mass	68	May	84.21	7.75	1.57	1.48	96.40	1.23	0.00	1.63	88.80	11.20	5.30	0.99	1.54	3.37	20.01	2.22
Providence River, R. I	70	do	79.01	10.30	2.58	2.13	95.05	1.48	0.00	2.41	84.79	15.21	7.12	1.65	2.23	4.21	17.00	2.59
Clinton, Conn	103	Nov	80.91	9.67	1.86	2.29	96.02	1.10	0.02	2.21	88.21	11.09	5.13	0.88	2.24	2.84	24.87	2.76
Stony Creek, Conn	55	Apr	81.02	10.46	1.60	2.76	96.12	0.83	0.01	2.72	90.11	9.89	4.64	0.64	2.73	1.95	18.90	1.89
Do	75	May	82.09	9.81	1.48	2.55	96.33	0.63	0.05	2.61	90.89	9.11	4.19	0.60	2.59	1.73	19.15	1.75
Do	105	Nov	77.82	10.60	2.32	2.51	95.40	1.36	0.01	2.33	84.83	15.17	6.94	1.39	2.44	4.40	18.23	2.76
Do	203	Mar	80.42	10.38	1.85	2.22	95.30	1.42	0.03	2.50	87.19	12.81	6.31	1.02	2.34	3.14	20.50	2.62
Do. (average of 4 samples)			80.34	10.33	1.81	2.51	95.79	1.06	0.02	2.54	88.24	11.76	5.52	0.9[illegible]	2.52	2.80	19.20	2.26
Fair Haven, Conn	54	Apr	81.30	9.89	2.05	2.20	94.00	2.06	0.02	3.19	85.12	14.88	7.53	1.44	2.50	3.41	18.06	2.69
Do	93	Nov	76.24	10.96	2.47	2.01	94.43	2.14	0.02	2.43	85.25	14.75	6.[illegible]4	1.26	2.22	5.03	24.31	3.59
Do	210	Mar	80.80	9.89	2.05	1.85	95.12	1.94	0.03	2.21	84.64	15.36	7.75	1.28	2.92	3.81	16.59	2.55
Do. (average of 3 samples)			79.44	10.25	2.19	2.02	94.52	2.06	0.02	2.61	85.00	15.00	7.17	1.33	2.54	4.08	19.65	2.95
Norwalk, Conn	118	Dec	81.33	9.52	1.51	2.10	96.46	0.75	0.01	2.32	90.04	9.90	4.50	0.65	2.23	2.52	17.85	1.78
Do	151	Feb	80.50	9.97	1.89	2.15	96.32	0.76	0.02	2.50	89.60	10.40	4.69	0.82	2.35	2.54	17.05	1.77
Do. (average of 2 samples)			80.92	9.75	1.70	2.13	96.39	0.77	0.02	2.41	89.82	10.18	4.59	0.73	9.29	2.51	17.45	1.76
Blue Point, N. Y	56	Apr	76.77	10.06	2.30	1.93	94.33	2.31	0.09	1.91	81.70	18.30	8.22	1.72	1.92	6.46	18.62	3.41
Do	107	Nov	75.55	13.31	2.02	2.58	96.89	0.75	0.01	1.90	88.30	11.70	5.81	0.82	2.17	2.90	16.17	1.95
Do	182	Feb	83.97	8.81	1.62	1.59	96.87	0.92	0.01	1.70	90.15	9.85	5.00	0.85	1.64	2.36	15.42	1.52
Do. (average of 3 samples)			78.76	10.73	1.98	2.03	96.03	0.31	0.04	1.88	86.75	13.28	6.34	1.13	1.91	3.91	16.74	2.33
Rockaway, N. Y	58	Apr	81.27	9.18	2.13	1.67	95.06	1.60	0.04	2.26	87.06	12.94	6.00	1.25	1.92	3.85	18.40	2.40
Do	112	Nov	77.66	10.53	2.72	2.02	94.79	1.76	0.01	2.50	89.31	15.69	7.06	1.66	2.23	4.74	19.84	3.13
Do. (average of 2 samples)			79.46	9.85	2.43	1.85	94.92	1.68	0.03	2.40	85.65	14.35	6.53	1.46	2.07	4.29	10.12	2.75
Long Island Sound, N. Y	60	Apr	84.47	8.14	1.68	1.41	96.35	1.30	0.09	0.85	89.67	10.33	5.24	0.98	1.17	3.03	16.23	1.69
Do	92	Nov	78.51	11.61	1.84	2.52	93.81	2.29	0.02	3.16	83.64	16.36	8.50	1.23	2.73	3.90	14.62	2.39
Do	109	do	82.79	8.41	1.74	1.71	96.64	1.09	0.01	1.87	90.15	9.85	4.56	0.82	1.79	2.68	17.59	1.73
Do. (average of 3 samples)			81.92	9.39	1.75	1.88	95.60	1.56	0.04	1.96	87.79	12.21	6.10	1.01	1.89	3.20	16.15	1.97
Oyster Bay, N. Y	180	Feb	77.90	10.61	2.35	2.19	95.31	1.46	0.01	2.37	84.34	15.66	7.19	1.48	2.26	4.73	17.27	2.70
East River, N. Y	57	Apr	79.92	10.44	2.16	1.74	95.44	1.63	0.02	1.57	87.57	12.43	6.31	1.10	1.87	3.15	20.28	2.52
Do	108	Nov	75.22	10.07	2.87	1.87	94.87	1.81	0.09	2.33	83.35	16.65	6.39	1.72	2.06	6.48	20.31	3.38
Do. (average of 2 samples)			77.57	10.25	2.52	1.81	95.16	1.74	0.06	1.95	85.46	14.54	6.35	1.41	1.97	4.82	20.30	2.87
Shrewsbury, N. J	61	Apr	81.65	8.20	2.20	1.33	95.07	2.06	0.04	1.83	85.37	14.63	6.48	1.60	1.47	5.08	17.52	2.56
Do	106	May	77.58	9.68	2.66	1.88	95.35	1.88	0.04	1.96	85.17	14.83	6.24	1.54	1.91	5.14	19.67	2.93

Do	181	Nov	81.73	9.13	2.00	1.68	96.52	1.38	0.01	1.72	89.16	10.84	4.87	1.60	1.70	3.27	19.23	2.08
Do. (average of 3 samples)			80.32	9.00	2.29	1.63	95.65	1.76	0.03	1.83	86.57	13.43	5.88	1.38	1.69	4.49	18.81	2.53
Norfolk, Va	59	Apr	83.86	9.32	1.45	1.82	96.83	1.05	0.01	1.64	91.45	8.55	4.50	0.61	1.71	1.73	11.18	0.95
Potomac River, Va. (transplanted)†	73	May	78.87	9.81	2.27	2.54	95.51	1.42	0.01	2.47	86.60	13.40	5.92	1.22	2.51	3.75	12.15	1.63
Do†	84	Nov	82.06	9.06	1.93	1.58	95.69	2.05	0.01	1.19	87.36	12.64	6.25	1.18	1.43	3.78	16.66	2.11
Do†	85	..do	77.90	10.31	2.33	2.17	94.99	1.81	0.02	2.47	86.14	13.86	6.19	1.21	2.31	4.15	16.13	2.23
Do. (average of 3 samples)			79.61	9.74	2.18	2.10	95.40	1.76	0.01	2.04	86.70	13.30	6.12	1.20	2.08	3.89	14.98	2.00
Rappahannock River, Va. (transplanted)	72	May	82.61	8.49	1.90	1.58	97.24	1.01	0.01	1.38	89.77	10.23	4.88	0.99	1.52	2.73	15.17	1.53
James River, Va. (transplanted)†	71	..do	83.49	8.26	1.78	1.71	95.91	1.17	0.01	2.56	90.05	9.95	4.63	0.84	2.16	2.48	13.79	1.41
Do†	82	Nov	77.99	10.63	2.61	2.21	94.74	1.95	0.05	2.54	84.15	15.85	7.00	1.67	2.33	4.85	15.00	2.38
Do†	83	..do	82.77	8.75	1.91	1.55	95.22	2.14	0.13	1.42	86.95	13.05	8.00	1.31	1.51	2.23	17.17	2.19
Do. (average of 3 samples)			81.42	9.23	2.10	1.82	95.29	1.76	0.07	2.17	87.05	12.95	6.54	1.27	2.00	3.19	15.32	1.98
Average of 34 samples (average of averages)			80.52	9.04	2.04	1.96	95.76	1.42	0.03	2.09	87.30	12.70	5.95	1.15	2.03	3.55	17.70	2.32
Oysters, "solids" (out of shell): ‡																		
Fair Haven, Conn	89	Nov	84.04	7.12	1.96	0.86	96.19	1.60	0.02	0.55	85.21	14.79	6.60	1.77	0.83	5.50	100.00	14.79
Do	204	Mar									88.44	11.56	5.91	1.54	0.89	3.22	100.00	11.56
Virginia (transplanted)†	104	Nov	85.50	7.51	1.83	1.12	96.43	1.43	0.02	0.77	87.23	12.77	6.38	1.54	1.06	3.79	100.00	12.77
Do	202	Mar									87.90	12.10	6.44	1.57	0.77	3.63	100.00	12.10
Do. (average of 4 samples)											87.19	12.81	6.33	1.60	0.89	4.07	100.00	12.81
Oysters, "cove" (canned):																		
Chesapeake Bay	74	May	78.53	14.00	3.78	1.60	93.57	1.77	0.27	1.21	86.01	13.99	7.89	2.04	1.42	2.51	100.00	13.99
Do	97	Nov	76.75	13.25	4.35	1.63	93.35	1.40	0.09	0.91	85.14	14.86	7.25	2.19	1.27	4.25	100.00	14.86
Do	120	..do	77.25	13.44	4.24	1.45	90.57	1.88	0.12	1.10	84.60	15.40	7.00	1.96	1.26	5.18	100.00	15.40
Do. (average of 3 samples)			77.51	13.46	4.12	1.56	92.50	1.70	0.16	1.08	85.25	14.75	7.38	2.06	1.32	3.98	100.00	14.75
Scallops (Pecten irradians):																		
Shelter Island, N. Y	56	Mar									77.79	22.21	15.05	0.03	1.48	5.65	100.00	22.21
Do	63	Apr									82.84	17.16	14.44	0.30	1.29	1.13	100.00	17.16
Do. (average of 2 samples)											80.32	19.68	14.75	0.17	1.38	3.38	100.00	19.68
Long clams (Mya arenaria) (in shell):																		
Boston, Mass	69	May	77.96	14.55	1.79	2.76	95.73	0.49	0.01	3.29	86.11	13.89	8.13	0.98	3.00	1.78	53.90	7.50
Clinton, Conn	102	Nov	78.57	14.86	1.78	2.49	96.02	0.69		2.81	86.11	13.89	8.69	1.01	2.63	1.56	57.92	8.05
Do	201	Mar	79.94	12.62	1.69	3.11	96.77	0.69	0.01	2.05	85.00	15.00	7.60	1.18	2.79	3.43	56.30	8.45
Do. (average of 2 samples)			79.26	13.74	1.74	2.80	96.40	0.66	0.01	2.43	85.56	14.44	8.15	1.09	2.71	2.49	57.11	8.25
Long Island, N. Y	65	Apr	81.05	12.52	1.52	1.56	94.76	1.30	0.03	2.93	86.05	13.95	8.40	0.97	2.06	2.52	57.64	8.04
Average of 4 samples (average of averages)			79.42	13.63	1.68	2.37	95.63	0.82	0.02	2.88	85.91	14.09	8.23	1.01	2.59	2.29	56.44	8.17
Long clams, canned:																		
Penobscot Bay, Me	122	Nov	74.63	17.94	2.92	3.18	91.92	2.44	0.04	1.72	84.54	15.46	9.06	1.27	2.34	2.79	100.00	15.46
Round clams (Venus mercenaria) in shell:																		
Little Neck, N. Y	66	Apr	78.24	11.59	0.74	2.22	95.12	0.88	0.02	3.17	86.20	13.80	6.56	0.40	2.67	4.17	31.71	4.38
Round clams, canned:																		
Islip, Long Island, N. Y	125	Nov	75.56	16.70	1.27	2.33	90.52	4.07	0.26	3.26	82.91	17.09	9.54	0.68	3.74	3.13	100.00	17.09
Mussels (Mytilus edulis) in shell:																		
Stony Creek, Conn	139	Dec	78.67	12.51	1.67	1.73	94.23	1.77	0.13	2.25	84.16	15.84	8.69	1.12	1.91	4.12	50.66	3.02
Lobster (Homarus americanus) in shell:																		
Maine	50	Mar									84.30	15.70	11.63	1.82	1.63	0.62	52.52	8.24
Do	62	Apr									81.77	18.23	14.00	1.55	1.71	0.92	36.24	6.60
Do	239	..do									79.17	20.83	17.24	1.45	1.62	0.52		

* In sample as received for analysis; in the majority of cases the whole animal, including both edible portion and shell.
† To New Haven, Conn.
‡ Shell contents, including flesh and liquids.

TABLE XIX.—*Percentages of water and nutritive ingredients in specimens of American invertebrates used for food*—Continued.

Name and locality of specimen.	Laboratory No. of specimen.	Specimen received.	Edible portion.														In whole sample.*	
			In flesh.				In liquids.				In edible portion. (Flesh plus liquids.)							
			Water.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Ash.	Water.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Ash.	Water.	Water-free substance.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Ash.	Carbohydrates.	Total edible portion.	Total water-free substance, actual nutrients.
				P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Lobster (Homarus americanus) in shell:																		
Massachusetts	69	May									82.11	17.89	15.03	2.54	1.87		30.56	5.47
Do. (average of 4 samples)											81.84	18.16	14.49	1.84	1.71		39.77	6.80
Lobster, canned:																		
Maine	76	May									79.36	20.64	16.75	0.46	2.78	0.65	100.00	20.64
Do	121	Nov									76.15	23.85	19.52	1.68	2.15	0.50	100.00	23.85
Do. (average of 2 samples)											77.75	22.25	18.13	1.07	2.47	0.58	100.00	22.25
Crayfish, in shell:																		
Potomac River, Va	64	Apr									81.22	18.78	16.00	0.46	1.31	1.01	12.30	2.31
Crab (Callinectes hastatus) in shell:																		
New Jersey	101	Nov									77.07	22.93	16.64	1.96	3.13	1.20	44.16	10.12
Crabs, canned:																		
Hampton, Va	124	Nov									80.98	19.02	15.62	0.79	1.78	0.83	100.00	19.02
Do	274	Apr									78.95	21.05	15.98	2.30	2.10	0.67	100.00	21.05
Do. (average of 2 samples)											79.97	20.03	15.80	1.54	1.94	0.75	100.00	20.04
Shrimp, canned:																		
Gulf of Mexico	123	Nov									70.80	29.20	25.38	1.00	2.58	0.24	100.00	29.20

* In sample as received for analysis; in the majority of cases the whole animal, including both edible portion and shell.

It would seem from the figures in Table XIX that the northern oysters are, on the whole, richer in nutritive material than the southern, but more analyses are needed to show the true average ranges of variation. One reason why the Virginia oysters appear to disadvantage here may be that they were younger. It appears that as the oyster grows older, at least up to a certain time, not only do the proportions of flesh and liquids increase more rapidly than the shells, but the proportion of natural nutrients in the edible portion increases also; that is to say, 100 pounds of young oysters in the shell would appear from these analyses to contain less of flesh and of liquids than 100 pounds of older ones, and when both have been shucked a pound of shell contents from the older animals would contain more nutriment than a pound from the younger. I wish, however, to be very careful in making these statements, because the number of examinations is too small to warrant very definite generalizations; indeed, the only figures which bear directly upon this especial point are those for the oysters transplanted from the James and Potomac Rivers to New Haven Harbor in the spring and taken out in the following fall or winter. These show a notable increase during this period, both in the quantities of shell contents in a given weight of shell and in the amount of actual nutriment in a given weight of shell contents. Perhaps this change is more a matter of feeding and fattening than of age. However it may be, it is not unnatural that changes of this kind, which take place in other animals, should occur in the oyster. Thus calves and pigs in growing and in fattening increase in both the proportion of meat to bone and in the proportion of nutritive material in the meat. As regards shellfish, this particular point especially demands more extended study.

The figures of Table XIX show a slight difference between the average composition of the edible portion of the oysters taken from the shell in the laboratory and that of those purchased out of the shells, in the form commonly called "solids" in the markets. Whether this difference is accidental or due to the fact that as they are ordinarily shucked for sale less of the liquids is saved than was done in preparing our specimens for analysis, it is impossible to say.

Table XIX is somewhat complex, and calls for further explanation. The specimens of oysters are arranged according to locality, from Buzzard's Bay, Massachusetts, to the James River, Virginia. The proportions of water, protein, fat, and mineral matters in the flesh and in the liquids are given separately. The proportions of carbohydrates are not stated, since they are not directly determined by the analysis, but are estimated by subtracting the sum of the protein, fat, and ash from the total water-free substance, which latter is determined along with the percentage of water, and is the difference between the latter and 100. Details of the methods of analysis may be found in Part I.

The last two columns of the table, it will be observed, give the percentages of total edible portions and of total nutrients in the edible

portion of each specimen as received for analysis. Where the specimen consisted simply of the edible portion, as in the case of the "solids" of oysters, canned oysters, etc., the percentage of total edible portion is, of course, 100.

I have already stated that some of the conclusions as to the values of fats, which are ordinarily drawn from the chemical composition of meats and fish, are not ventured upon here because the precise nature of the nutritive ingredients of oysters and other shellfish is not definitely understood.

Perhaps further experimental study will show that what we call the protein of the oyster is very nearly the same as that of meat or milk; that what we reckon as carbohydrates of the shellfish have about the same nutritive value as the carbohydrates of other foods—milk, sugar, and starch, for instance. Meanwhile, what is known implies that the differences are probably not very great, though they may be considerable.

The composition of the liquid portion demands a few words of explanation. The amount of nutriment is very small indeed, the principal constituents being water and salts of sea water. How much food value these minute quantities of nutriment have it is impossible to say. Perhaps a given weight of what is called protein in the liquids of oysters may be not far inferior to the same quantity in the flesh, but this is a matter of doubt.

Taking all in all, the variations in composition of oysters are very wide. The same would very likely be found to be the case with clams and other shellfish if a large enough number of analyses were made to show the range of variation, but probably the averages of the analyses here given represent pretty nearly the average composition of the shellfish as they are ordinarily found in the water and in the markets.

Most of the specimens of oysters and other shellfish here reported upon were received without statement as to whether they had been "floated" or not, but we suppose that, except when otherwise stated, they had usually been floated and the specimens were such as are ordinarily sold. The effect of floating on the composition is described in another place in this report. Briefly stated, floating increases the proportions of water and diminishes the proportions of nutritive ingredients, and especially those of mineral salts. Floated oysters will therefore have on the average more water and less nutritive material than those not floated. The same is true of clams, mussels, etc.

It is then safe to say that while the variation in the composition of oysters, clams, and the like are considerable, just as they are in different kinds of meat, such as beef, mutton, and pork, yet it is probable that the proportions which are expressed in the figures of Table I, and graphically set forth in the colored diagram, make a reasonably fair exhibit of the average composition of these food materials in the condition in which we ordinarily buy them, and hence represent pretty nearly their relative nutritive values. While we must wait for further

research before we can with perfect confidence accept these figures as the actual measure of the nutritive effects, we may say, in a general way, that the relative food values are indicated very nearly by the chemical compositions as here given.*

The cheapest food is that which furnishes the actually nutritive material at the lowest cost. The most economical food is that which is cheapest and best adapted to the wants of the user. Various methods have been proposed for estimating the relative cheapness or dearness of food materials. For instance, the cost of actually nutritive ingredients in a given food material may be computed by comparing the amounts of the several nutrients, protein, fats, and carbohydrates it contains, with its market price, 1 pound of protein being assumed to cost, on the average, five times as much, and a pound of fats three times as much as a pound of carbohydrates. The computed costs of the same nutrient, *e. g.*, protein, in different foods, thus affords a basis for comparing the relative expensiveness of the foods, as in the figures below. †

Comparative costs of protein in food materials.

Food materials.	Ordinary price per pound.	Cost of protein per pound.
Beef, sirloin, medium fatness	$0.25	$1.06
Beef, sirloin, at lower price	.20	.85
Beef, round, rather lean	.16	.63
Mutton, leg	.22	.91
Milk (7 cents per quart)	.03½	.53
Salmon, early in season	1.00	5.11
Salmon, when plenty	.30	1.53
Mackerel	.10	.79
Salt cod	.07	.43
Oysters (25 cents per quart)	.12½	1.68
Oysters (50 cents per quart, choice)	.25	3.35
Lobsters	.12	2.09
Wheat flour	.03	.11

Shellfish are delicacies rather than staple foods. The above figures illustrate the fact that, like other delicacies, they are not economical from the strictly pecuniary standpoint, yet they have an important use. The conditions of our advanced civilization make variety in diet desirable, and to a greater or less extent essential, and oftentimes flavor has a value which can not be counted in dollars and cents.

The nutritive value of the shellfish, as of other foods, depends to a considerable extent upon their digestibility, but so little is positively known of the digestibility of shellfish as compared with meats and other animal foods that it has not seemed fitting to say a great deal

* See article on "Pecuniary Economy of Food" in Century Magazine for January, 1888.

† This method of computation is German; assumed relative costs of the nutrients are based upon market prices in Germany. The protein is selected for the estimate because it is physiologically the most important of the nutrients. For other and more accurate, though more complex, methods see seventeenth annual report of Massachusetts Bureau of Statistics of Labor, 1886, p. 253.

about it here. Perhaps, indeed, the most that can be said is that while there are people with whom such substances do not always agree, yet oysters belong to the more easily digestible class of foods.

FOOD VALUE OF FISH.

The ingredients of the flesh of fish are essentially the same in kind as those of the flesh of domestic animals used for food, such as beef and mutton. The chief difference is that the flesh of fish contains relatively less fat and more water than ordinary meats. Or, to put it more specifically, the flesh of fish contains in general about the same proportion of protein, less fat, more water, and hence on the whole less nutritive material, pound for pound, than that of domestic animals used for food. Thus we have in the flesh of flounder only 16 per cent., and in that of cod 18 per cent., of nutrients, while ordinary lean beef has from 25 to to 33 per cent., and the fatter meats considerably more. The fatter kinds of fish, however, as herring, mackerel, salmon, shad, and whitefish approach nearer to medium beef. Dried and salted fish also contain good proportions of nutrients, the specimens of ordinary salt codfish having 28 per cent., salt mackerel 47, and desiccated cod, a material as yet less known commercially, 82 per cent. of nutrients. The edible portion of shellfish is poor in nutrients, oysters varying from 9 to 19, and lobsters averaging 18 per cent.

Fish as found in the markets generally contain more refuse, bone, skin, etc., than meats, as is illustrated in Tables VI and VIII. With the larger proportions of both refuse and water the proportions of nutrients, though variable, are usually much less than in meats. Thus a sample of flounder contained 67 per cent. of refuse, 28 of water, and only 5 per cent. of nutritive substance, while the salmon averaged 23, the salt cod 22, and the salt mackerel 36 per cent. of nutrients. The nutrients in meats ranged from 30 per cent. in beef to 46 in mutton and 87½ in very fat pork (bacon). The canned fish compare very favorably with the meats. It is worth noting that the nutrients in dressed fresh codfish, in edible portion of oysters, and in milk were nearly the same in amount, about 12½ per cent., though differing in kind and proportions.

Vegetable foods have generally less water and more nutrients than animal foods. Ordinary flour, meal, etc., contain from 85 to 90 per cent. or more of nutritive material. But the nutritive value is not proportional to the quantity of nutrients, because the vegetable foods consist mostly of carbohydrates, starch, sugar, cellulose, etc., of inferior nutritive effect, and because their protein is less digestible than that of animal foods. Potatoes especially contain a large amount of water and extremely little protein or fats.

PLACE OF FISH IN DIETARIES—IMPORTANCE OF FISH-CULTURE.

The chief uses of fish as food are (1) as an economical source of nutriment and (2) to supply the demand for variety in diet, which increases with the advance of civilization and culture.

As nutriment, the place of fish is that of a supplement to vegetable foods, the most of which, as wheat, rye, maize, rice, potatoes, etc., are deficient in protein, the chief nutriment of fish. The so-called nitrogenous extractives (meat extract), contained in small quantities in fish as in other animal foods, are doubtless useful in nutrition.

There is a widespread notion that fish contains large proportions of phosphorus, and is on that account particularly valuable for brain food. The percentages of phosphorus in the analyses above reported are not larger than are found, according to the best analyses, in the flesh of other animals used for food. The number of reliable determinations of flesh in the latter are, however, small, and it is, though very improbable, yet within the range of possibility that a more complete investigation of the subject might reveal a smaller proportion of phosphorus in meats than in fish.

But even if the fish be richer in phosphorus, there is no proof that it would on that account be better for brain food. The question of the nourishment of the brain and the sources of the intellectual energy are too indeterminate to allow decisive statements and too abstruse for speedy solution. There is no experimental evidence to warrant the assumption that fish is more valuable than meats or other food material for the nourishment of the brain.

It is an interesting fact that the poorer classes of people and communities almost universally select those foods which chemical analysis shows to supply the actual nutrients at the lowest cost; but, unfortunately, the proportions of the nutrients in their dietaries are often very defective. Thus, in portions of India and China, rice; in Northern Italy, maize-meal; in certain districts of Germany, and in some regions and seasons in Ireland, potatoes; and among the poor whites of the southern United States maize-meal and bacon make a large part and in some cases almost the sole food of the people. These foods supply the nutrients in the cheapest forms, but are all deficient in protein. The people who live upon them are ill-nourished and suffer physically, intellectually, and morally thereby.

On the other hand, the Scotchman finds a most economical supply of protein in oatmeal, haddock, and herring; and the rural inhabitants of New England supplement the fat of their pork with protein of beans, and the carbohydrates of potatoes, maize, and wheat flour with the protein of codfish and mackerel, and, while subsisting largely upon such frugal but rational diets, are well nourished, physically strong, and noted for their intellectual and moral force.

Late inquiry in agricultural and biological chemistry has brought out some facts which emphasize the importance of fish-culture and the

greater use of fish as food, from the standpoints of hygiene and domestic, agricultural, and even national economy.

Our national dietary is one-sided. Our food contains relatively too much of fat, sugar, and starch, and too little of protein. This is a natural result of our agricultural conditions which have led to the production of large quantities of maize, which is relatively deficient in protein, and of excessively fat beef and pork. Our agricultural production is, in this sense, one-sided.

Our soils are becoming depleted by culture. The evil results of this are already evident in the older and are becoming so even in some of the newer States of the Union. Of the ingredients of plant food which are needed for the restoration of fertility, the costliest and scarcest is nitrogen, which is the characteristic element of the protein compounds of our food.

A very large amount of the waste products which are left from the consumption of food, instead of being returned to the soil for restoring its fertility and increasing its production, is carried off in drainage waters and through the sewers of large cities into the rivers and sea. The nitrogenous products are thus especially exposed to loss. The nitrogen, however, is not lost necessarily in this way. It goes for the support of marine vegetation which forms the food of fish. It may thus again be utilized as food for man. Fish has relatively less of fats and more of protein than meats and vegetable foods. By fish culture, then, we are enabled to supply the very materials which are lacking in our dietaries and from the waste products may be saved the valuable fertilizing elements, including phosphorus and especially nitrogen.

As population becomes denser, the capacity of the soil to supply food for man gradually nears its limit. Fish gather materials that would otherwise be inaccessible and lost, and store them in the very forms that are most deficient in the produce of the soil. Thus, by proper culture and use of fish, the rivers and sea are made to fulfill their office with the land in supplying nutriment for man.

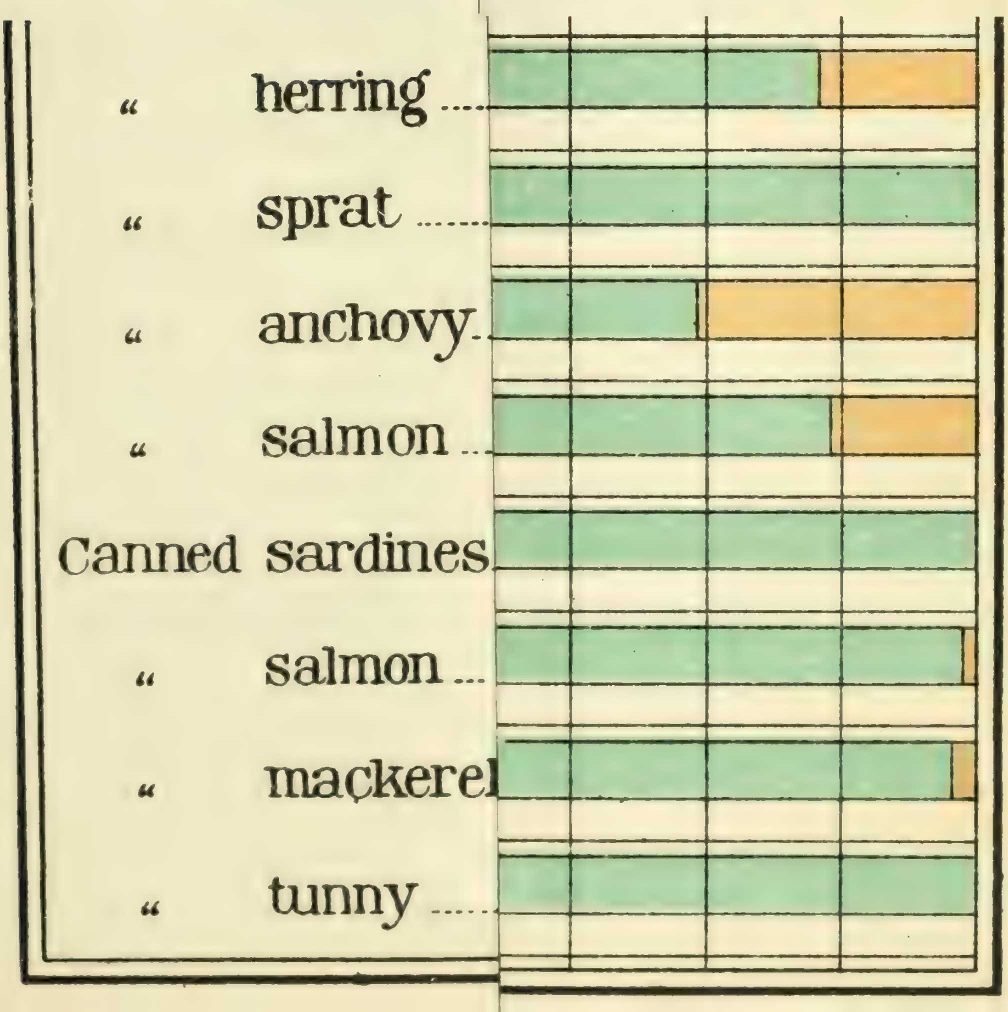
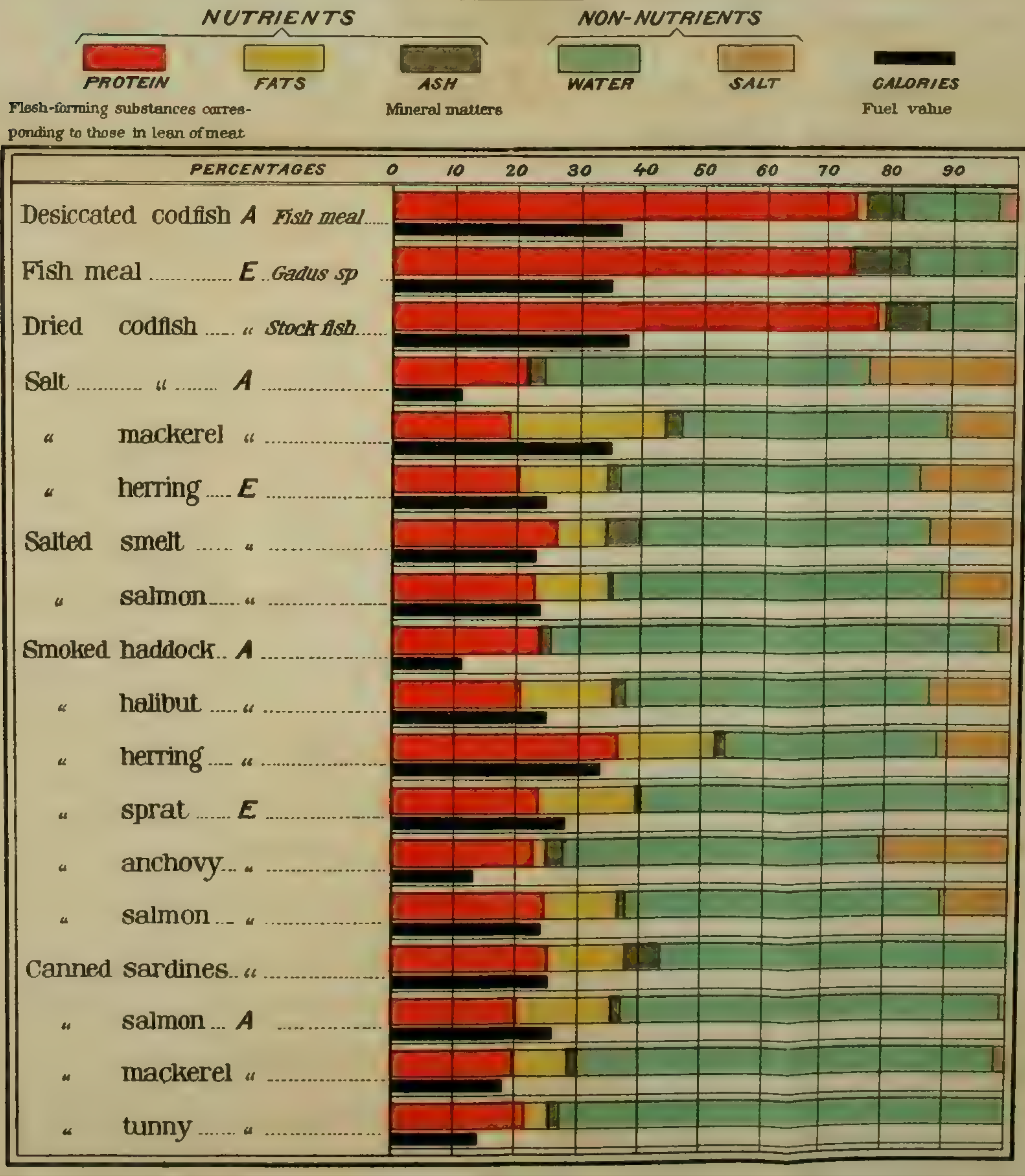

" herring
" sprat
" anchovy
" salmon
Canned sardines
" salmon
" mackerel
" tunny

CHART B.

PERCENTAGES OF NUTRITIVE INGREDIENTS, WATER AND SALT, IN FLESH, EDIBLE PORTION, OF SPECIMENS OF AMERICAN AND EUROPEAN PRESERVED FISH.

A INDICATES AMERICAN FISHES. *E* INDICATES EUROPEAN FISHES.

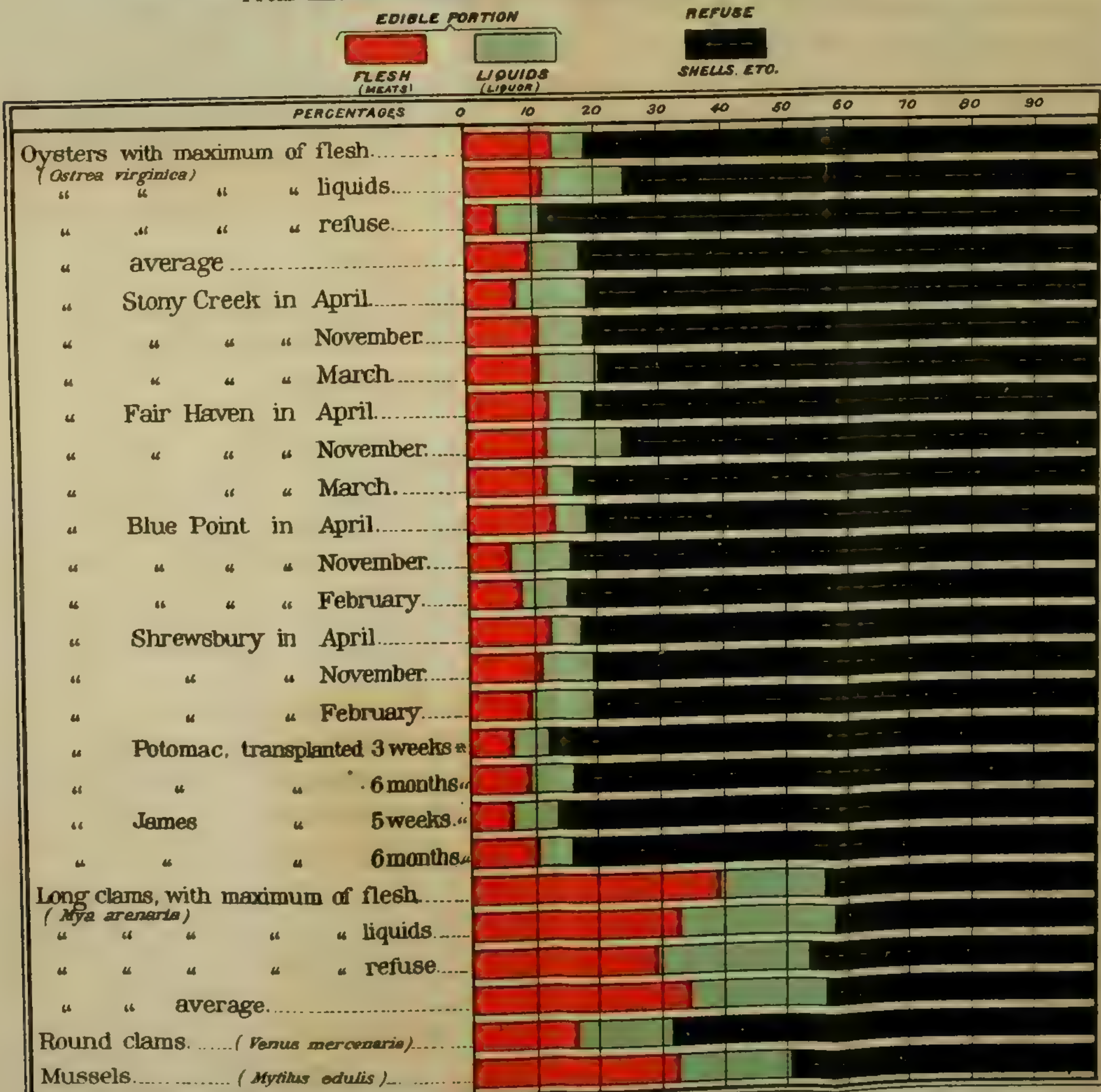


" "	
" Potomac, tran	
" "	
" James	
" "	
Long clams, with maxin (*Mya arenaria*)	
" " " "	
" " " "	
" " average..	
Round clams........(*Ven*	
Mussels..............(*Myt*	

* *Transplanted in April to*
after lying in the New

CHART. D.

PERCENTAGES OF FLESH, LIQUIDS, AND SHELLS
IN SPECIMENS OF OYSTERS, CLAMS AND MUSSELS.
From different Localities and from the same Locality at different times.



× *Transplanted in April to New Haven, Conn., and then taken after lying in the New Haven beds for the time indicated.*

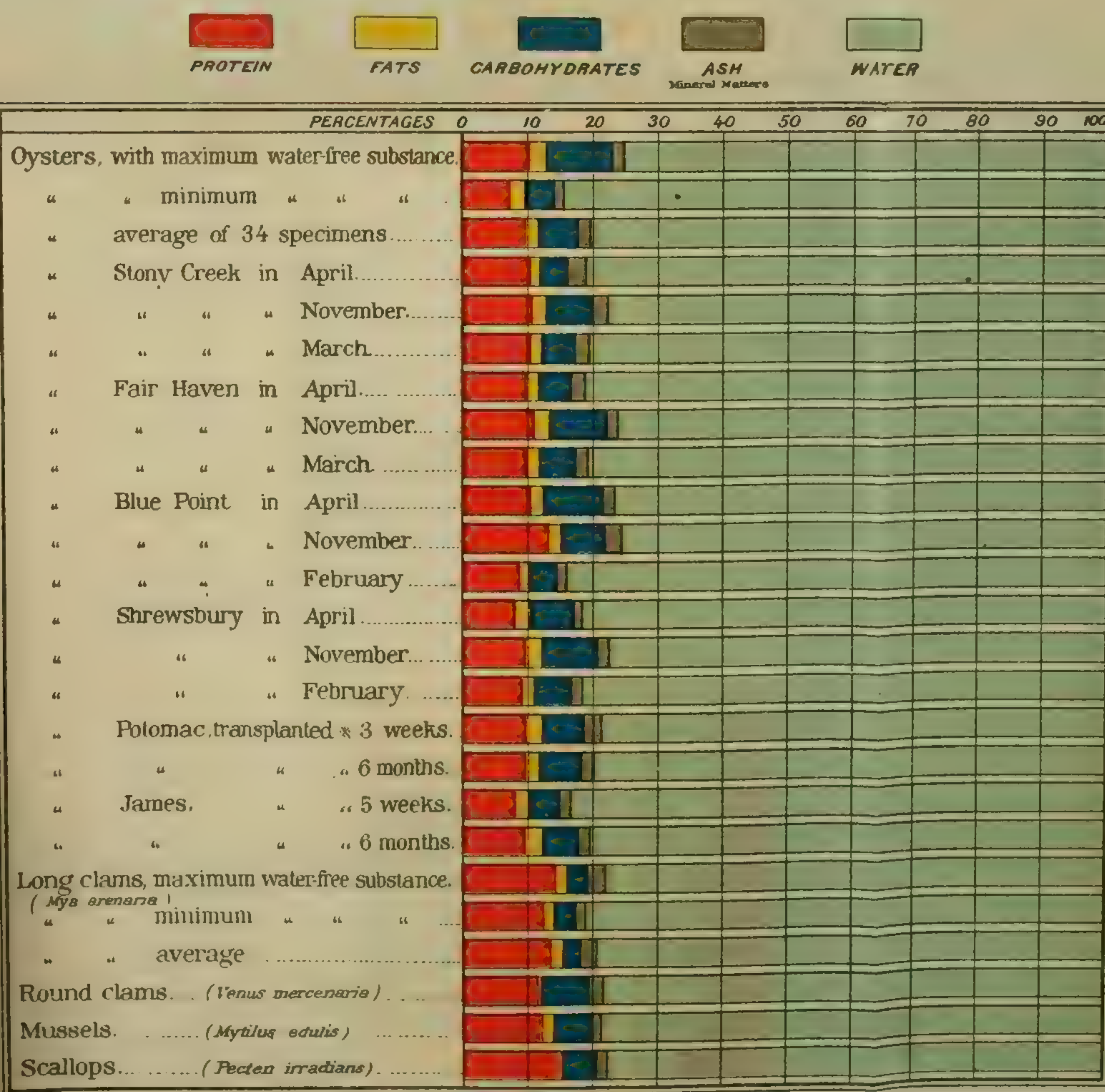
" " " Febr				
" Potomac, transplanted ※				
" " " "				
" James, " "				
" " " "				
Long clams, maximum water-free (*Mya arenaria*)				
" " minimum " "				
" " average				
Round clams...... (*Venus mercenari*				
Mussels.............. (*Mytilus edulis*).				
Scallops............ (*Pecten irradian*				

※ *Transplanted in April to New Hav*
after lying in the New Haven beds k

CHART E.

PERCENTAGES OF NUTRITIVE INGREDIENTS AND WATER
— IN FLESH —
OF SPECIMENS OF OYSTERS, CLAMS, MUSSELS, AND SCALLOPS.

From different localities, and from the same locality at different times.



* *Transplanted in April to New Haven, Conn, and taken after lying in the New Haven beds for the time indicated.*

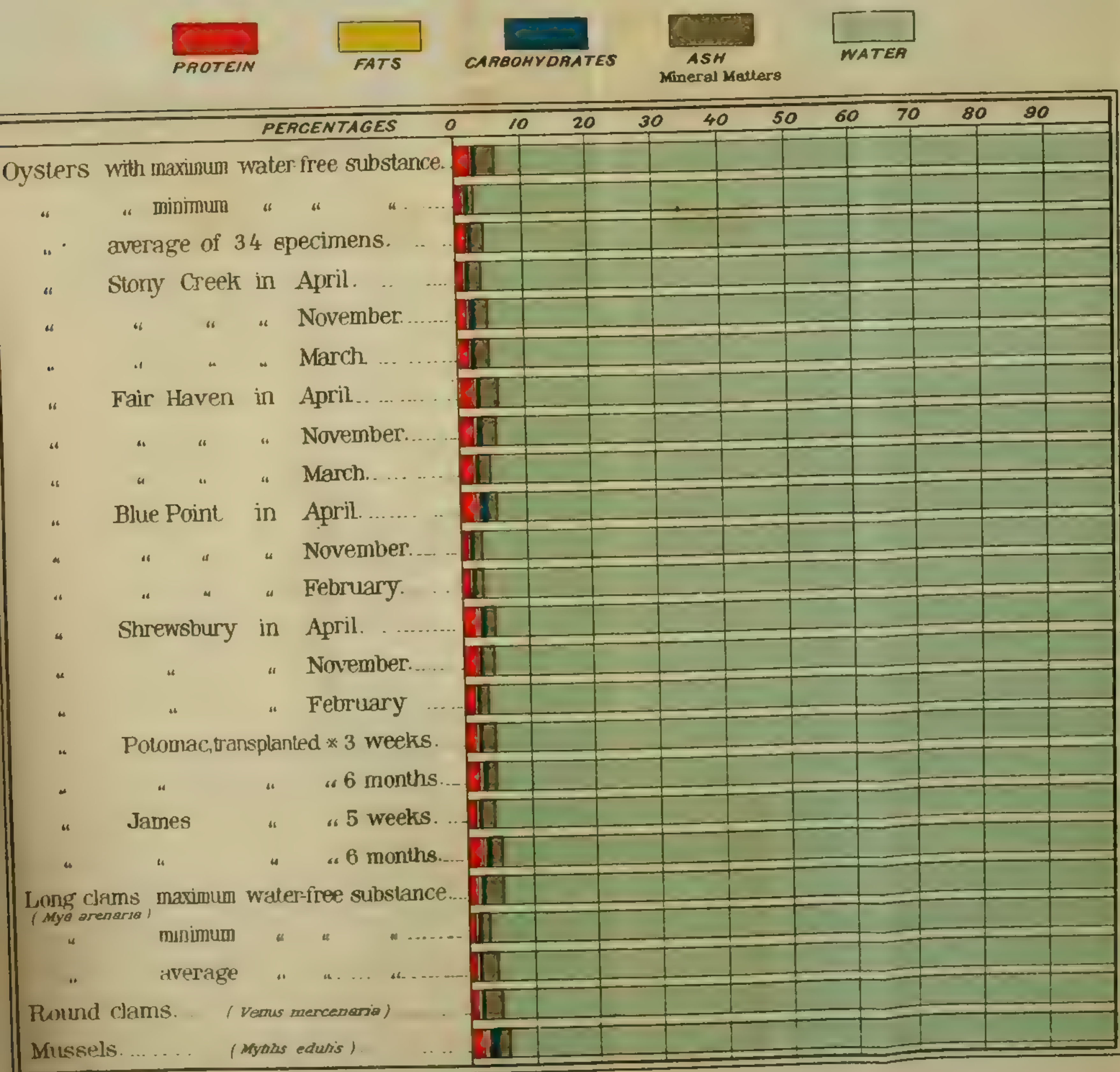
" " " "				
" James " "				
" " " "				
Long clams maximum water-free (*Mya arenaria*)				
" minimum " "				
" average " " ...				
Round clams. ...... (*Venus mercena*				
Mussels. .... (*Mytilis edulis*)				

× *Transplanted in April to New Ha*
after lying in the New Haven bed

CHART F.

PERCENTAGES OF NUTRITIVE INGREDIENTS AND WATER IN LIQUIDS OF SHELL CONTENTS OF SPECIMENS OF OYSTERS, CLAMS, AND MUSSELS.

From different localities and from the same locality at different times.



× *Transplanted in April to New Haven, Conn, and then taken after lying in the New Haven beds for the time indicated.*

" " " Febr				
" Potomac, transplanted * 3				
" " " " 6				
" James " " 5				
" " " " 6				
Long clams, maximum water-free (*Mya arenaria*)				
" " minimum " "				
" " average				
Round clams. ....(*Venus mercenaria*				
Mussels. .... (*Mytilus edulis*) ...				

* *Transplanted in April to New Ha*
after lying in the New Haven beds

CHART G.

PERCENTAGES OF NUTRITIVE INGREDIENTS AND WATER IN SHELL CONTENTS, FLESH AND LIQUIDS, OF SPECIMENS OF OYSTERS, CLAMS, AND MUSSELS.

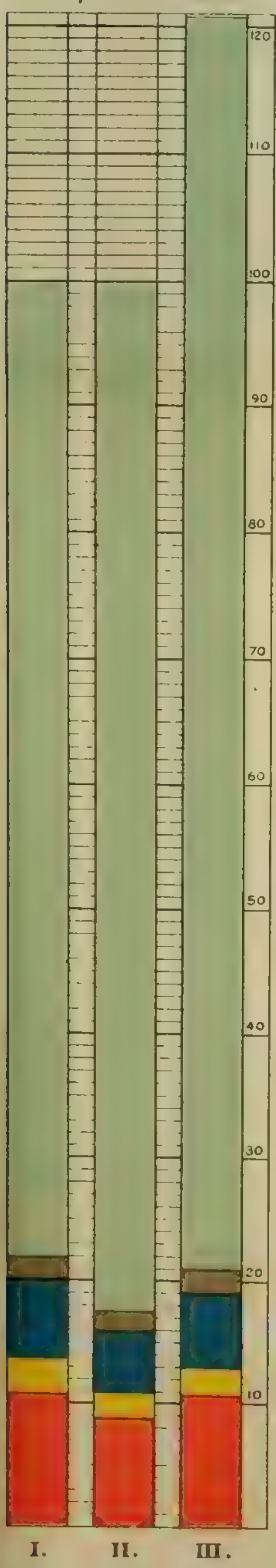
From different localities, and from the same locality at different times.

* Transplanted in April to New Haven, Conn., and taken after lying in the New Haven beds for the time indicated.

Chart H.

Changes in Composition of Flesh of Oysters in Floating.

Experiment 1.



Water.

Nutritive Ingredients.

MINERAL MATTERS.
Salts, e.g. Chlorides, Sulphates, etc.

CARBOHYDRATES.
Substances allied to Starch, Sugar, etc.

FATS.
Substances more or less similar to the fat of meat, butter, and the fatty and oily matters of wheat, potatoes, etc.

PROTEIN.
Flesh (muscle) forming substances like those in the "lean" of meats and fish, casein (curd) of milk, gluten of wheat, etc.

I *Constituents in 100 parts by weight before floating.*

II *Constituents in 100 parts by weight after floating.*

III *In floating, 100 parts were increased to 120.8 and 113.6 in the respective experiments.*

Experiment 2.

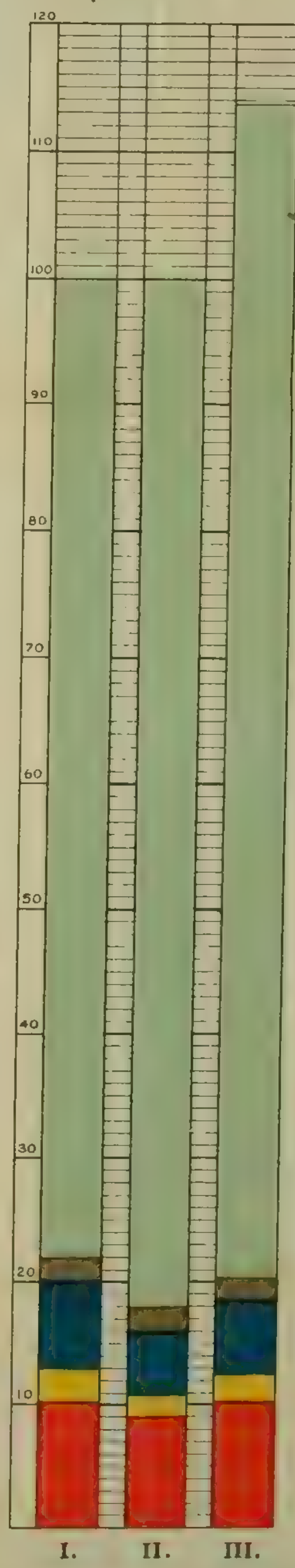
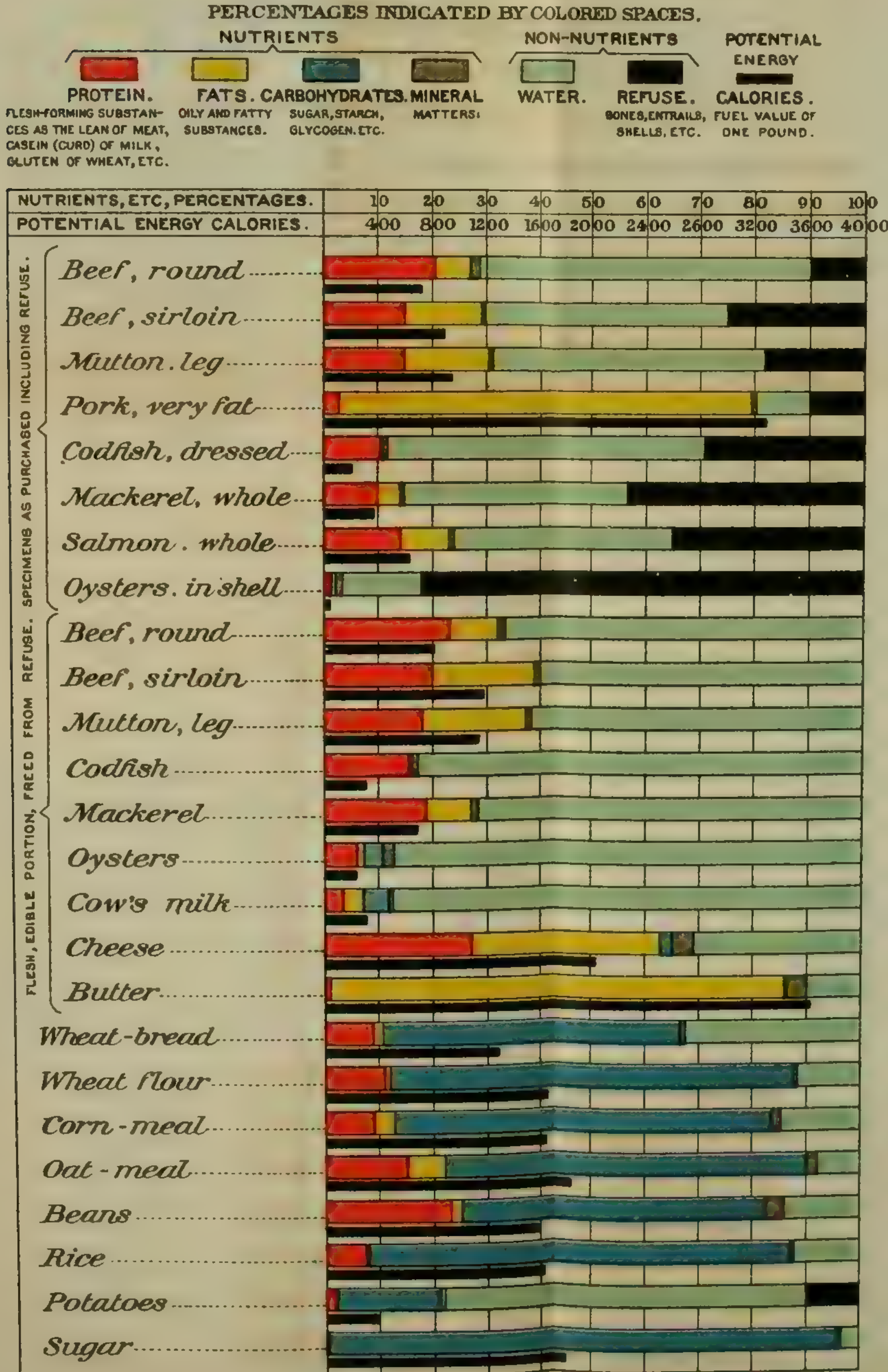


Chart I.

Nutritive Ingredients and Refuse, and Amounts of Potential Energy in Food Materials.



.—REPORT UPON THE PARTICIPATION OF THE U. S. FISH COMMISSION IN THE CENTENNIAL EXPOSITION, HELD AT CINCINNATI, OHIO, IN 1888.

By J. W. Collins.

ORIGIN AND OBJECTS OF THE EXPOSITION.

The occurrence of the one-hundredth anniversary of the settlement Cincinnati, and the desire of the public-spirited men of that city to ly commemorate that important event in its history, originated the tempt to hold an exposition. A resolution having been passed that he one-hundredth anniversary of the settlement of Cincinnati, curring in 1888, be properly celebrated," a committee was appointed, ich promptly organized and developed plans for holding an extensive r of more than ordinary local importance, which was denominated The Centennial Exposition of the Ohio Valley and Central States, cluding the States of the Northwest Territory and those which border on the Ohio and even farther South."

Invitations were extended to other States and Territories to partici-te in the exposition, the object of which was announced to be chiefly e illustration of the development of the region designated as the Ohio Valley and Central States" during the century ending in the lebration of the settlement of Cincinnati. It is scarcely pertinent to is report to more than allude, in passing, to the importance of thus monstrating the material progress of a section of our country which celebrated for its great natural resources and the industry, energy, d business activity that have always characterized its people.

Exposition buildings, etc.—Cincinnati provided for the exposition assigning to its use the Music Hall and the so-called "permanent position" building; also by granting the use of Washington Park, uated directly opposite the above-named structures, for the purpose erecting, temporarily, the main exposition buildings. An elevated ched walk, crossing Elm street, connected the temporary buildings th the Music Hall and the permanent exposition, while in the rear of e latter an additional structure was erected along the line of the iami Canal for the accommodation of manufacturing machinery. The

area covered by the exposition buildings afforded a floor space of 400,000 square feet in round numbers, with an additional wall space of 142,500 square feet.

Participation of States and action of the Ohio legislature.—In response to the invitations extended, several States decided to participate in the exposition. The enterprise was heartily indorsed by the neighboring towns of Covington and Newport, while the Ohio legislature appropriated money for a State representation, authorized the appointment of honorary commissioners, and also directed the governor, on behalf of the State, to invite "the assistance and coöperation of the Federal Government," etc.

Authorization of exhibit by the Federal Government.—As a result of this legislation the governor of Ohio extended to the President and Congress an invitation for the Federal Government to participate in the exposition. There was some delay in the action of Congress, but eventually the following measure was passed by both Houses, and was signed by the President:

Whereas, the States which comprise the Northwest Territory and the adjacent States will hold at Cincinnati, Ohio, from July 4 to October 27, 1888, a centennial exposition commemorative of the organization of the Northwest Territory, under the ordinance of 1787, in which exposition all the States and Territories of the United States and the General Government have been invited to participate, the object being in said exposition to present a panorama of the nation's resources and present state of progressive development, by an exhibition of the products of agriculture, of the various industries and fine arts; also the results of advancement made in the sciences; the whole illustrating the opportunities secured to and the possibilities which wait upon the citizens of this Republic; and

Whereas, the citizens of the Ohio Valley and the several States adjacent thereto have made suitable and adequate preparation and arrangements for holding said exposition and are desirous—and it being fit and proper—that the several Executive Departments of the Government, the Department of Agriculture, the Smithsonian Institution, including the National Museum and Commission of Fish and Fisheries, should participate in such exhibition; therefore,

Be it enacted, etc., That the head of each of the several Executive Departments of the Government, the Commissioner of Agriculture, and the Smithsonian Institution, including the National Museum and Commission of Fish and Fisheries, under the direction of the President of the United States, be, and they are hereby, authorized and directed to prepare and make suitable exhibits at the said centennial exposition of the Ohio Valley and Central States, to be held at Cincinnati, beginning on the 4th of July and closing October 27, 1888.

That there shall be appointed a committee of Congress composed of ten members, five to be appointed by the President of the Senate, and five by the Speaker of the House of Representatives. Said committee is authorized and directed to visit said exposition and make such report to Congress in that behalf as they may deem needful and proper: *Provided*, That the President may in the exercise of his discretion allow such documents and exhibits as relate to early settlement at Marietta, Ohio, and the establishment of civil government in the territory northwest of the Ohio River, to be taken to Marietta and exhibited during the time from July 15 to 19, 1888, inclusive, under such care and custody as he may direct.*

* It was not practicable for the Fish Commission to participate in the exhibit at Marietta, for reasons that appear elsewhere, and also because the collections included nothing specially suitable for the occasion.

That to enable the several Executive Departments of Government, the Department of Agriculture, and the Smithsonian Institution, including the National Museum and the Commission of Fish and Fisheries, to participate in said exposition, to be held as aforesaid, there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, $147,750, apportioned as follows:

For the War Department, $7,150.

For the Navy Department, $15,000.

For the State Department, $2,500.

For the Treasury Department, $7,500.

For the Interior Department, $36,100.

For the Department of Agriculture, $20,000.

For the Post-Office Department, $5,000.

For the Department of Justice, $2,000.

For the Smithsonian Institution, including the Commission of Fish and Fisheries, $50,000.

For the expenses of the Committee of Congress, $2,500.

That the President may, if in his judgment it shall be deemed necessary and expedient in order to secure the best results with greatest economy, transfer a part of the fund hereby apportioned to one Department or bureau to another Department or bureau. The term bureau wherever used herein shall be construed to include the Agricultural Department, the Smithsonian Institution, and Commission of Fish and Fisheries.

That the President of the United States is hereby authorized to detail an officer of the Pay Department of the Army or Navy to disburse the fund appropriated by this act.

The payments on account of expenses incurred in carrying out and into effect the provisions hereof shall be made on itemized vouchers approved by the representative of the Department incurring the liability and a person to be designated by the President to make final audit of said accounts: *Provided*, That payment of the expenses incurred by the committee of Congress shall be made on vouchers approved by the chairman of said committee.

That the head of each of said Executive Departments and of the Department of Agriculture, Smithsonian Institution, and Commission of Fish and Fisheries shall, from among the officers or employés thereof, appoint a suitable person to act as representative of such Department or bureau, and said representative shall, under the direction and control of the head of the Department or bureau, supervise the preparation and conduct of the exhibits herein provided for.

That no officer or employé appointed as aforesaid shall be paid extra or additional compensation by reason of services rendered in virtue of such employment; but nothing herein shall be so construed as to prevent the payment of the just and reasonable expenses of any committee, officer, or employé appointed or employed under or by virtue of the provisions of this act.

That all articles imported from the Republic of Mexico or the Dominion of Canada for the purpose of being exhibited at said exposition shall be admitted free of duty, subject, however, to such conditions and regulations as the Secretary of the Treasury may impose and prescribe.

Additional explanatory legislation.—The decision on the part of the Auditor that the law, as enacted, did not give authority for the purchase of new material by the Departments or bureaus to complete exhibits, and the fact that he held that only such collections or materials as were then on hand could legitimately be utilized for exhibition purposes, led to the passage by Congress of supplementary legislation declaring the meaning of the previous act and authorizing the purchase of suitable material, etc.

Appointment of auditor and disbursing officer.—In compliance with the provision of the law regarding the audit and payment of the expenses of the Government in connection with the exposition, and soon after the passage of the bill, the President designated Hon. Anthony Eickhoff, Fifth Auditor of the Treasury Department, as special auditor to make final audit of the accounts, and directed that Maj. John S. Witcher be detailed as disbursing officer.

PREPARATION OF THE FISH COMMISSION EXHIBIT.

The following is a list of persons connected with the preparation and conduct of the exhibit of the U. S. Fish Commission:

Marshall McDonald, U. S. Commissioner of Fish and Fisheries.
Joseph William Collins, representative of the U. S. Fish Commission, in general charge.

COLLABORATORS.

Richard Rathbun, assistant, in charge of the division of scientific inquiry, U. S. Fish Commission, Washington, D. C.
John A. Ryder, PH. D., professor of comparative embryology, University of Pennsylvania, Philadelphia, Pa.
Dr. William H. Dall, curator of the department of mollusks, U. S. National Museum, Washington, D. C.
Dr. R. E. C. Stearns, adjunct curator, department of mollusks, U. S. National Museum, Washington, D. C.
Stephen G. Worth, superintendent of Central station, U. S. Fish Commission, Washington, D. C.
I. S. K. Reeves, passed assistant engineer, U. S. Navy, consulting engineer of the U. S. Fish Commission, Washington, D. C.
James A. Henshall, M. D., secretary Cincinnati Society of Natural History, Cincinnati, Ohio.
Charles H. Gilbert, professor of natural history, University of Cincinnati, Cincinnati, Ohio.
S. P. Bartlett, M. D., secretary Illinois State fish commission, Quincy, Ill.
George H. H. Moore, superintendent of distribution, U. S. Fish Commission, Washington, D. C.
Herbert A. Gill, disbursing agent, U. S. Fish Commission, Washington, D. C.
Newton W. Simmons, in charge of car No. 1, U. S. Fish Commission, Washington, D. C.
Frank L. Donnelly, messenger, U. S. Fish Commission, Washington, D. C.
John B. Williams, superintendent of Baird station, U. S. Fish Commission, Baird, California.
Sherman F. Denton, artist, U. S. Fish Commission, Washington, D. C.
Charles B. Hudson, artist, U. S. Fish Commission, Washington, D. C.
H. R. Center, U. S. Fish Commission, Washington, D. C.
P. T. Yeatman, U. S. Fish Commission, Washington, D. C.
Henry Horan, superintendent U. S. National Museum, Washington, D. C.
C. A. Steuart, assistant superintendent U. S. National Museum, Washington, D. C.
W. J. Huddleston, game warden, Hamilton County, Ohio.

IN CHARGE OF SPECIAL EXHIBITS.

Fishes and mollusks: Tarleton H. Bean, M. D., ichthyologist of the U. S. Fish Commission.
Aquarial exhibit: William P. Seal, aquarial expert, U. S. Fish Commission.

Fish-culture: William F. Page, fish-cultural expert, U. S. Fish Commission.
Collection illustrating scientific research: M. P. Greenman, microscopist, University of Pennsylvania, Philadelphia, Pa.

GENERAL ASSISTANTS.

Edward C. Bryan, stenographer, U. S. Fish Commission, in charge of accounts.
William H. Abbott, U. S. Fish Commission.
Robert E. Lewis, U. S. Fish Commission.
William P. Sauerhoff, expert fish-culturist, U. S. Fish Commission.
William H. Morgan, expert fish-culturist, U. S. Fish Commission.
F. J. Barry, machinist, U. S. Navy, detailed to duty in U. S. Fish Commission.
W. H. Horan, U. S. Fish Commission.

Appointment of the representative.—On June 9, in conformity with the act of Congress, the Commissioner, Col. Marshall McDonald, formally designated me as the representative of the U. S. Fish Commission and instructed me to assume responsible charge and direction of the preparation, installation, etc., of the exhibit to be made by the Commission. Pending this, however, I had practically assumed, under the direction of the Commissioner, the duties of representative.

Funds available.—As will be seen by reference to the act of Congress, a lump sum of $50,000 was appropriated "for the Smithsonian Institution, including the Commission of Fish and Fisheries." By an arrangement between the Commissioner and the Secretary of the Smithsonian Institution a division of this appropriation was made, by which the Fish Commission received $10,000.

Preliminary visit to Cincinnati.—Before the scope and character of the Fish Commission exhibit could be satisfactorily determined it was necessary to obtain definite information from official sources concerning the area and location of space that could be obtained for the display. It was specially important that the location should be such as to afford every practicable facility for obtaining a large supply of water, since, if this requisite could be secured, it was proposed to make a display of living fish and other aquatic forms, including plants, a marked feature of the exhibit. It was also necessary to have a considerable amount of water for the proper display of various forms of fish-cultural apparatus, models of fish-ladders, etc., while it was, of course, indispensable for hatching fish. Therefore, as soon as preliminary arrangements could be made for the preparation, during my absence, of certain material for the exhibit, I went to Cincinnati on a trip of observation and for the purpose of meeting the exposition authorities and securing from them the information which was desired. Leaving Washington June 2, I arrived at Cincinnati the following evening.

Mr. R. E. Earll, deputy representative of the Smithsonian Institution, had gone to Cincinnati a few days previously for a purpose similar to my own. As soon as practicable after my arrival, we visited the exposition buildings together, where we had a conference with the management, including President James Allison. Upon inspection, it

was seen that the wing of the Park Building, which had been provided for the accommodation of the Government exhibits, was entirely inadequate for the purpose, it having only about 13,000 feet of floor space, no more than was required by the Smithsonian Institution and the U. S. Fish Commission. But the management were not only quick to appreciate what was needed, but prompt to act. It was immediately decided to provide the requisite space, so far as the limits of the Park would permit, by constructing additional buildings; plans were prepared and contracts made with the least possible delay, while the assurance was given that the "Government Annex" would be completed sufficiently early to permit the installation of the exhibit before July 4, the date fixed upon for the opening of the Exposition.

The plans contemplated as a part of the annex the construction of a wing running north from the structure originally intended for the use of the Government, and since the northern end of this was to be near the large water pipes entering the exposition grounds it was deemed a favorable location for the Fish Commission exhibit. It was learned that the management would afford to the aquarial display all practicable facilities, among which may be mentioned all the electric lights required for lighting the aquaria. Arrangements were made for storing boxes, trucking material, and much useful information was obtained concerning the terminal facilities of different railroads, and such other matters as were directly connected with the transportation and installation of exhibits.

I returned to Washington on June 8, and immediately set to work to prepare the exhibit.

Organization of a board.—Previous to my appointment in charge of the Fish Commission exhibit the representatives of the other Departments had informally met and organized as a board, this action being taken to facilitate the transaction of certain business connected with the Government display in which all the Departments had a common interest. Col. Cecil Clay, representative of the Department of Justice, was selected by the board for its chairman; Mr. Haughwout Howe, representative of the State Department, as secretary, and Mr. Marcellus Gardner, representative of the Department of the Interior, was appointed in charge of the preparation of certain forms of stationery.

Because of some indefiniteness in the law and a misunderstanding resulting therefrom concerning the status of the Fish Commission there was at first some difficulty in securing for it the proper recognition, though the matter was satisfactorily arranged after proper explanations had been made.

The organization of the board was generally beneficial, since the several Departments, acting in an organized manner, could facilitate the accomplishment of business common to all and generally carry it on more economically than if each had acted independently.

Plan and scope of the Fish Commission exhibit.—The object of the ex-

hibit was to show, as far as practicable, the results accomplished in the scientific investigation of the waters, in the study of the methods, relations, and statistics of the fisheries, and in the artificial propagation and acclimatization of fishes, whereby certain important industries are chiefly maintained. The plan of the exhibit, which I submitted to the Commissioner June 13, 1888, was substantially carried out. The following extracts show the general scope:

(1) The scientific investigations and explorations which have been and are now being conducted by the Fish Commission.

(2) The history, present methods, and importance of fish-culture, together with the system of distribution of fish and fish eggs, which may be properly considered under the head of fish-culture. In connection with this it seems to me desirable that there should be an exhibition of live fish in aquaria, chiefly representing species which have been propagated by the efforts of the Commission. Also, it is important to show the most improved system of fishways, since these have an intimate relation with the question of propagation, which might be seriously impeded, if not rendered absolutely abortive, unless some successful method is devised to enable fish to ascend rivers during their breeding season.

(3) Fisheries, including (*a*) specimens of the more important economic species; (*b*) apparatus, photographs, paintings, crayons, etc., illustrating the capture of fishes; (*c*) vessels, boats, photographs, sketches, etc., illustrative of the flotilla employed in the fisheries of the United States.

The plan and scope of the display were limited by the space and means available for the installation. By agreement with the representatives of the other Departments, it was decided to place the Fish Commission exhibit in the north end of the "Park Building;" but the space allotted was less than 3,000 feet of floor area, rectangular in form, 95 by 31 feet.* The wall space, however, was comparatively ample, measuring 31 feet in length on each side and 95 feet across the end of the building. Additional space of this kind was afforded by the screens separating the Fish Commission section from that occupied by the Smithsonian Institution and National Museum. The wall space was especially important, since it afforded the requisite background for the aquaria and gave opportunity for the proper display of numerous pictures and maps illustrative of fisheries, fish-culture, etc.

Work on the collections, etc.—The time available for the preparation and assembling of the collections was exceedingly short. The scope of the exhibit was not determined until after my return from Cincinnati, June 8. The arrangement for a division of the appropriation between the Fish Commission and the National Museum was not arrived at until after June 20.

---

* The total available space for the Government exhibits amounted to 42,000 square feet of floor. Of this, the following assignments were arranged by the board: State Department, 750 feet; Treasury Department, 4,250 feet; War Department, 4,000 feet; Navy Department, 4,750 feet; Interior Department, 6,000 feet; Department of Agriculture, 4,000 feet; Post-Office Department, 2,500 feet; Department of Justice, 750 feet; Smithsonian Institution and National Museum, 12,000 feet; U. S. Commission of Fish and Fisheries (about) 3,000 feet.

Several of the chief assistants were absent from Washington and consequently could not assume the duties assigned them until late in June. As the exposition opened on July 4, and much new material had to be prepared, packed, shipped, and installed, the outlook was discouraging.

Mr. Seal had charge of the aquaria, and began making necessary arrangements for a live-fish display soon after the passage of the bill authorizing the Commission to participate in the exposition and considerably in advance of the preparation of other material. All the preparatory work was pushed with the utmost vigor; day after day every one labored late into the night until the collections were ready.

The exhibit illustrating the scientific work of the Commission was brought together through the assistance of Mr. Rathbun, on whose recommendation Mr. M. P. Greenman was appointed to have charge of it; the fish-cultural exhibit was prepared under the joint direction of Mr. Worth and Mr. Page, and Dr. Bean acted as chief assistant in assembling and installing the material illustrative of the methods and relations of the fisheries, including the objects of fishery, statistics, etc.

The preparation of the exhibit was facilitated by the withdrawal of certain material from the National Museum, together with a few cases and screens.* Early in July the material for the aquarial exhibit was shipped from Washington, and shortly thereafter the bulk of the other collections were forwarded.

INSTALLATION AND CONDUCT OF EXHIBIT.

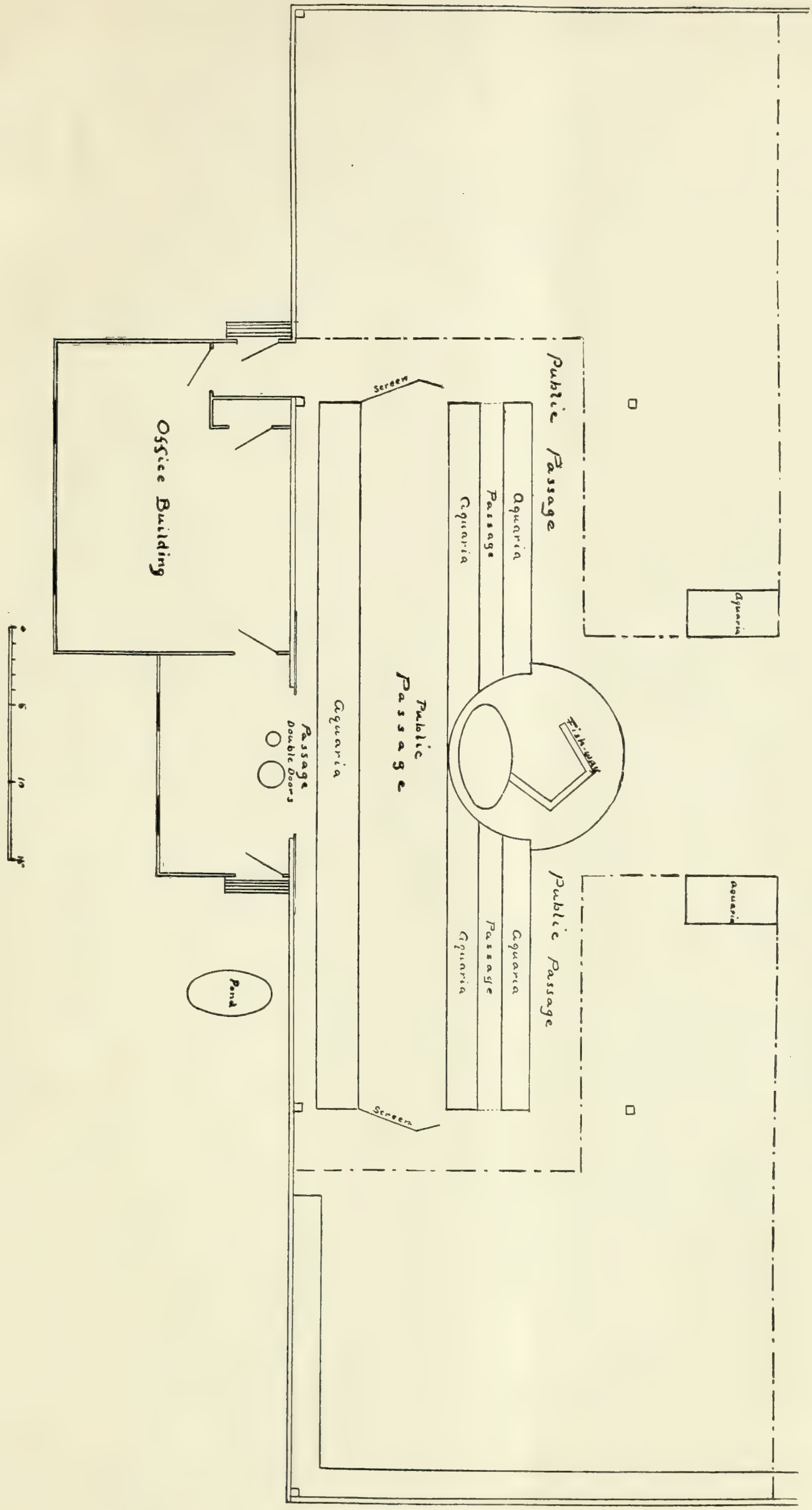
Allotment of space.—The space allotted to the exhibit was so much less than was required that crowding of the collections was unavoidable. The arrangement of the collections had to conform, in a large measure, to the requirements of the live-fish exhibit. It had been decided that the most satisfactory location for this was against the wall of the north end of the annex, where a central space 45 feet long by 16 feet wide was allotted to it, in addition to the area required for a pond and additional aquaria, as shown on the plan. The scientific and fish-cultural collections were placed on the east of the main entrance to the Fish Commission space, while the material illustrative of fisheries, etc., occupied the other side.

The accompanying plan shows the relative positions of the several sections and the area covered by each.

Offices, etc.—With the permission of the exposition authorities small annexes were built, wherein were located the filters, tools, and ice required for the aquarial display, and also a small office room.

---

*Almost without exception, the material withdrawn from the Museum constituted a part of the fisheries collection brought together by the Fish Commission, or included specimens obtained by the Commission in its scientific explorations and subsequently deposited in the Museum.



GROUND PLAN OF THE FISH COMMISSION SECTION.

Considerable difficulty was met with in arranging the live-fish display. In accordance with the plan for this part of the exhibit a structure representing a section of a rocky sloping hillside was erected for the reception of the aquaria, a row of which was arranged around the front, while two rows were placed on either side of a grotto-like passageway (6 feet wide) that ran from end to end beneath the hill. There were twenty-one tanks in all thus located, besides which two larger tanks were placed on trestles on each side of the main avenue connecting the Smithsonian and National Museum exhibit with that of the Fish Commission. In the center of the hill a tiny rivulet tumbled down the steep and broken declivity, fell into a basin below, and thence passed through a McDonald fishway (or ladder) to a miniature pond on the floor.

It will readily be understood that, even under the most favorable conditions imaginable, the erection of such a structure, the installation of aquaria, the building of a miniature pond, the preparation for lighting the aquaria by electricity, and the arrangements for filtering and regulating the temperature of the water required much labor and special skill. The building of the structure was, however, pushed forward with all possible diligence. A double force was employed, one gang working during the day and the other at night. On account of the nature of the materials used in making the imitation rock-work, considerable time was consumed in getting the grotto into shape to admit visitors. It was completed in the latter part of July. The chief difficulty, however, lay in obtaining a sufficient supply of filtered water. The excessively muddy condition of the water made it imperative to filter all that was used, and the supply needed was large, since a continuous circulation had to be kept up to maintain the fish in a healthy condition.*

The most efficient method of obtaining a water supply and proper aëration of aquaria is that of having a very small stream delivered with strong pressure, and which, penetrating the surface of the water in the tanks, carries in with it a large amount of air that is dispersed in minute bubbles. The method of filtration must be adapted to this purpose. Certain unexpected obstacles were developed before the details were finally and satisfactorily completed, which not only delayed the work, but for a time appeared to make a successful exhibit of live fish impossible.

The pressure of water from the city mains at Cincinnati is very great, ranging from 60 to 75 pounds to the square inch. The chief difficulty, however, was due to an elevator run by hydraulic power, located not far from the Fish Commission exhibit, the operations of which caused excessive and rapid fluctuations of pressure, varying in an instant from

---

* There were 53 rainy days during the exposition period, and the Ohio River, usually low and comparatively clear during summer, was very high and phenomenally muddy during all this time. Nevertheless, after the conditions were fully understood and means found to control them, it was practicable to provide water of perfect clearness and brilliance.

60 to 120 pounds. The effect on the filters was like sledge-hammer blows, and resulted in breaking the diaphragms on three occasions, which allowed free alum to be circulated through the whole series of aquaria thus supplied. Nearly all of the fish were killed. Many attempts were made to control the pressure, but all efforts proved ineffectual until it occurred to Mr. Barry to apply a steam safety-valve to the supply pipe, and this solved the problem most satisfactorily.

On July 25 a large consignment of various species of trout was received from the Wytheville station and transferred to the aquaria. Fish and numerous aquatic plants were received from Washington at the same time. Later, additional supplies of trout were brought from Northville, Mich., while other species were received from the rivers in the vicinity of Quincy, Ill. The installation was completed July 25, when the first shipment of fish and plants was received, and considering all the disadvantages under which the work was accomplished, it may be considered creditable that such results were accomplished in less than three weeks from the time the first of our material reached Cincinnati.

The exhibit of the Commission was broadly grouped under three general heads: scientific inquiry, fish-culture, and fisheries; though the aquarial display, which was intimately associated with and related to each of the above-mentioned divisions, might be appropriately considered a separate section.

Under the head of scientific inquiry were exhibited models, photographs, and illustrations of the coast laboratories and the vessels used by the Commission for scientific research, including a special series of views of the station at Wood's Holl, Mass., and the scenery in the immediate vicinity. There were also full-sized specimens of apparatus employed in marine investigation, together with charts and models of the ocean showing results of exploration. Next came alcoholic and dried specimens of various forms of fishes, crustaceans, etc., and specimens of many small forms of life mounted on slides for the microscope; these, together with sections of fish eggs, sponges, etc., constituted a very interesting microscopical display. The publications of the Commission were also placed under this section. The fishes and other animals, mentioned elsewhere as "objects of fisheries," may appropriately be referred to here, since they have also been objects of scientific inquiry.

Under fish-culture was included an historical collection of apparatus used for the artificial propagation and distribution of fish; also photographs, transparencies, etc., showing the same in action. This collection embraced the most approved forms—full-sized specimens and models of apparatus now used for artificial hatching and for distributing fish and ova. Associated with these were models and illustrations of hatching houses, etc., including floating barges and steamers; a lay figure and numerous photographs, transparencies, and other devices, illustrating the methods of fish-culture; statistical charts showing the

results of artificial propagation of the shad, and models and other representations of fishways or fish-ladders for assisting anadromous fish in reaching their spawning grounds at the headwaters of streams in which artificial obstructions are placed. Many living specimens and casts of fishes which had been artificially hatched and raised were exhibited.

The fisheries section embraced the following:

(1) Objects of fisheries, such as marine mammalia, reptiles, batrachians, fishes, and mollusks. The former were shown by casts, paintings, photographs, lithographs, etc.; the reptiles and batrachians by living specimens, illustrations, etc.; the fishes by living specimens, casts, color sketches, etc., and the mollusks by living and dried specimens of the more important species.

(2) Series of large maps showing distribution of the most valuable species of fish and mollusks used for food and bait in the northwestern Atlantic, from Cape Hatteras to Labrador.

(3) Models, photographs, and illustrations of the various kinds of American fishing vessels and fishing boats, embracing an historical series of models.

(4) Photographs showing process of net making and mending.

(5) Charts of North Atlantic fishing-grounds.

(6) Illustrations of economic condition of fishermen, embracing photographs of fishermen, views in and about fishing towns and harbors, fishermens' dwellings and boarding houses; also dwellings of fishery capitalists who were formerly fishermen.

(7) Methods of fishing in the following branches illustrated by photographs, lithographs, and sketches:

(*a*) Fur-seal fishery; (*b*) whale fishery; (*c*) Beluga or white-whale fishery; (*d*) blackfish fishery; (*e*) porpoise fishery; (*f*) terrapin fishery; (*g*) flounder fishery; (*h*) halibut fishery; (*i*) cod fishery; (*j*) mackerel fishery; (*k*) bluefish fishery; (*l*) smelt fishery; (*m*) whitefish fishery; (*n*) salmon fishery; (*o*) shad fishery; (*p*) herring fishery; (*q*) eulachon fishery; (*r*) menhaden fishery; (*s*) dogfish fishery; (*t*) market fishery; (*u*) oyster fishery; (*v*) clam fishery; (*w*) crab fishery; (*x*) lobster fishery; (*y*) sponge fishery.

(8) The statistics of the fisheries of the United States were shown on a large map.

The aquarial display included numerous kinds of fresh-water fishes, among which were the following that had been artificially hatched and raised:

Rainbow trout (*Salmo irideus*).
Brook trout (*S. fontinalis*).
Brown or Von Behr trout (*S. fario*).
Loch Leven trout (*S. levenensis*).
Scale, leather, and mirror carp (*Cyprinus carpio*).
Paradise fish (*Macropodus venustus*).
Golden ide (*Idus auratus*).

Besides these there were many varieties of goldfish. In addition to the fishes, the aquaria contained numerous species of fresh-water shells and aquatic plants; also soft-shelled turtles, etc., which have been, to

a greater or less extent, subjects of inquiry by the Fish Commission. Explanatory labels were placed on all the tanks containing live fish.

The live-fish exhibit attracted marked attention and may be called a decided success, notwithstanding adverse conditions. Should circumstances permit a live-fish exhibit in the future, under more favorable auspices, I would feel it to be my duty to heartily recommend the undertaking. It is doubtful if in any other way knowledge of our economic fishes can be so readily conveyed to the people. The educational advantages offered by such an exhibit are beyond computation. But in addition to the value of such a display to the public, in this particular instance much was learned by the experts of the Commission through the experimental work at Cincinnati that will probably prove advantageous in the future. Most worthy of note was the fact developed that brook trout (*Salvelinus fontinalis*) will live in water with a moderately high temperature if the water is clear and well aërated. Mr. Seal succeeded in keeping trout in good condition in water having a temperature of 70°.

Deputy representative appointed, etc.—On August 2, Dr. T. H. Bean was placed in charge of the exhibit as deputy representative and acted in that capacity during my absence in the East on special duty until September 12.

Decrease of force.—Early in September four of the assistants were withdrawn from the exhibit. This reduction of the force, which was small enough before, added materially to the labors of those who remained. This was perhaps most noticeable in connection with the clerical duties incident to the accounts and correspondence, which devolved upon Mr. Bryan, who, in addition to his duty as stenographer, attended to all the accounts and gave much assistance elsewhere. It is scarcely necessary to add that, practically with no exception, his labors extended far into the night during the entire progress of the exposition, as well as for weeks after its close.

Collecting indigenous fish, etc., for aquaria.—In addition to the fish received from the U. S. Fish Commission stations and from Quincy, Ill., indigenous fishes and other aquatic animals were collected from the waters near Cincinnati, thus saving expense in transportation and securing more frequent additions to our aquaria. Mr. Page visited the Ohio River, near Lawrenceburg, Ind., on August 21, and brought back on the evening of the same day quite a variety of living specimens, among which was a blue catfish (*Ictalurus ponderosus*) weighing about 50 pounds. About once a week a party, usually in charge of myself, went out for this purpose, though additional collections were obtained by Mr. Seal and others from time to time. A great many species were collected, and the fish that were injured so that they were unfit for our purposes were given to Dr. James A. Henshall, secretary of the Cincinnati Museum of Natural History, or to Prof. Charles H. Gilbert, of the University of Cincinnati, both of whom accompanied us on some of

our trips and entered heartily into the work of collecting. Some specimens were also presented to the Cuvier Club of Cincinnati.

Several gentlemen who owned or controlled ponds near the city very generously gave us the opportunity to seine them, and it was specially gratifying that these friendly offers were made voluntarily and generally as a result of having seen our exhibit of live fish. In some cases the proprietors of ponds sent us specimens of living fish. For instance, on September 15 we received three fine, large specimens of buffalo fish from Mr. J. D. Rosse, proprietor of Rosse Lake, near Elmwood.

The best locality for obtaining collections was found to be on Little Miami River, near Remington, some 20 miles or so from Cincinnati. In this work not only was the privilege of seining in the waters near Cincinnati cheerfully accorded to the Fish Commission, but efficient aid was rendered by Mr. W. J. Huddleston, game warden of Hamilton County, through whose efforts and coöperation a creditable exhibit of live fish was maintained.

Trip to Lake Erie.—My proximity to the Great Lakes afforded a good opportunity for personally observing the methods of fishing and of handling fishery products in that region, so far as this could be done in a brief visit. For this purpose the Commissioner instructed me to go to the lakes, and I left Cincinnati on the evening of October 4 for Sandusky, Put-in Bay, and the Bass Islands. Many interesting observations were made at these places and considerable information was obtained which will be of value in connection with future investigations in this region. Having accomplished all that was deemed desirable, I returned to Cincinnati October 9.

Hatching salmon.—The continuance of the exposition into late autumn afforded a good opportunity to give a practical illustration of artificial propagation of fish. Therefore, in compliance with instructions from the Commissioner, 45,000 eggs of the California salmon (*Oncorhynchus chouicha*) were shipped September 17 and 19, from the station at Baird, Cal. These eggs were received about a week later in good order, and were transferred to the McDonald hatching jars in the fish-cultural section. So far as I am aware, this was the first attempt to hatch salmon in the McDonald jars, and the success attained, even with the muddy water, made the experiment a very valuable one. At first the result of this experiment was somewhat doubtful because of the muddy condition of the water, but on October 2 the young fry began to appear and on the 13th all had been successfully hatched. Eighty-nine per cent of the eggs hatched, which was a better result than is usually obtained under the best conditions.

This successful attempt to hatch California salmon was one of the most attractive exhibits, being a fine illustration of the work of fish-culture and a never-failing source of interest after the young fry appeared. Crowds gathered around the tables to watch the movements of the fry or the embryos breaking from the eggs, and so absorbingly interested

did many become that all else seemed forgotten and newcomers often found difficulty in getting near the point of attraction.

From Mr. Page's report on the hatching and distribution of these salmon it appears that the temperature of the hydrant water was at first reduced by the ice coil from a maximum of 78° to 60° F. From October 18 to October 28 considerable mortality was caused among the fry by muddy water and an epidemic disease. Upon the recommendation of Mr. John H. Bissell, commissioner of Michigan fisheries, 34,000 fry were planted in Traverse Bay, Michigan, October 29. The remaining fry were distributed in small lots to parties in the vicinity of Cincinnati. In the summer of 1889, Mr. Joseph Schlosser, of Covington, Ky., who had received a few hundred of the salmon and placed them in cold, spring-fed ponds, stated that they had thriven beyond expectation.

Distribution of fish.—As the exposition drew near its close many people at Cincinnati and vicinity expressed their desire to receive live fish from the exhibit when the display was ended. The principal demand was for goldfish and carp, and as we did not have enough to meet this demand the Commissioner arranged to send 1,500 carp and 200 goldfish for distribution at Cincinnati about the date when the exposition closed. Thus the numerous applications filed in the office of the Fish Commission exhibit at the exposition were complied with. Most of the species, however, particularly those of the Ohio Valley, were sent to Washington for installation in the aquaria maintained by the Commission at Central Station for study.

Distribution of publications.—The interest aroused by the exhibit caused frequent demands for publications relating to fish-culture and the general work. At my request the Commissioner sent reports of this kind to the exposition, where they were distributed to persons especially interested in the operations of the Commission.

Every effort was made by the Fish Commission experts to convey information to the public concerning the fisheries, the work of the Commission, and the use of various devices employed in fish-culture and scientific explorations; and the appreciation of the exhibit was doubtless due to a better understanding gained in this way of the material displayed.

CLOSE OF EXPOSITION, ETC.

Change in date of closing.—It was the original intention to close the exposition on October 27, the date named in the bill authorizing the participation of the Federal Government. However, as the exposition neared its close it was determined by the management to continue it open until November 15, and a resolution passed Congress October 20, authorizing the exhibition of the Government collections until the date of closing. Later it was decided by the management to close the exposition on November 8, and that was the actual date of closing.

This change in the date of closing caused me much anxiety, for all

estimates for the exhibit had been based on the expectation that the exposition would close on October 27. By the closest economy it had been found possible to make the allotment of $10,000 suffice for our needs and the return of the material to Washington, but that was all, and it was evident that a continuance of the exhibit beyond the original date would involve expenditures which we had no means of defraying. The matter was promptly laid before the Commissioner and, upon proper representations having been made by him, the President decided to allot to the use of the Fish Commission exhibit the additional sum of $1,500.

Deputy representative appointed, etc.—My plans in connection with the work of the Division of Fisheries had been formed on the assumption that the exposition would close on October 27, and the pressing nature of some important affairs relating to the division made it impracticable for me to remain in Cincinnati much beyond that time. Therefore I left Cincinnati for Washington on November 4, and on the same date appointed Mr. E. C. Bryan a deputy representative in charge of the exhibit, to act under my direction, with instructions to pack and ship the collections as promptly as possible after the close of the exposition. This was satisfactorily accomplished, and on November 22 Mr. Bryan and party left Cincinnati for Washington.

On account of my absence from Washington, Mr. Bryan had charge, under the general direction of the Commissioner, of unpacking and renovating the collections and reinstalling such material as had been taken from the National Museum. This work was done in the most painstaking and creditable manner. In addition Mr. Bryan rendered very important service in connection with the correspondence and other clerical duties connected with the exhibit.

Disposition of material.—Some misunderstanding arose on the part of the officials of the Treasury and War departments concerning the disposal of material purchased for the exhibit of the Commission. However, when the proper explanations had been made, the matter was arranged to the entire satisfaction of all, for the officials concerned quickly saw the advantage to the Government of retaining valuable collections that might be needed at any time (besides being useful additions to the permanent exhibits in Washington), and for which only the most meager returns could be expected, if sold at auction, as at first contemplated.

As a matter of fact, all the material belonging to the Commission which it was intended to return to Washington was en route for that city before the representative was informed by Maj. Witcher of the order (270) of the War Department. Such material as was not deemed of special value to the Commission was turned over to Maj. Witcher; that which had been taken from the National Museum was reinstalled, and the remainder was, by direction of the Commissioner, turned over to the superintendent of Central station, Washington, D. C.

The great haste with which the exhibit was prepared made it unusually difficult to comply with the extraordinary demands in settling up affairs after the close of the exposition, when it became necessary to show in an itemized statement every individual object purchased and, as far as possible, the particular exhibit it was obtained for. Nevertheless, this duty was satisfactorily performed, though the labor involved was so great that the work was not completed until late in the winter following the close of the exposition.

Press comments.—The press showed a praiseworthy disposition to publish instructive and reliable articles on the fisheries, some of which were well illustrated. In this way tens of thousands became familiar with the fisheries who had known little or nothing of them before, and many persons were thus led to visit the exposition for the purpose of adding to their knowledge of these industries, as well as to become better informed as to the work and functions of the U. S. Fish Commission. There can be no question of the beneficial effect on the fisheries of thus bringing the citizens of our interior States to understand and appreciate their importance to the nation and the peculiar perils and hardships which attend their prosecution.

Material sent to Augusta Exposition.—On September 17 the Augusta National Exposition Company, through its commissioner, Charles S. Hill, requested that the Fish Commission, after the close of the Cincinnati Exposition, send certain collections illustrative of its workings to the national exposition to be held at Augusta, Ga., October 10 to November 17, 1888. In compliance with instructions from the Commissioner the material selected by Mr. Hill was sent to Augusta. The most important object sent was the collection of photographs illustrative of fisheries, which had attracted much attention at Cincinnati.

Courtesies.—I have pleasure in acknowledging, on behalf of the Fish Commission, the following courtesies:

The U. S. National Museum placed at the disposal of the Commission certain collections, cases, etc., while its experts were permitted to accept temporary employment from the Commission for the purpose of packing the more fragile material.

The U. S. Hydrographic Office furnished for exhibition a full set of its charts of the fishing banks off the northeast coast of America, many of which had recently been issued on a much improved plan. The series also included the coasts and harbors of Canada, Newfoundland, and Labrador, off which the fishing banks lie, and which are much frequented by American fishermen.

Acknowledgments are due Prof. John A. Ryder for the assistance given by him in the preparation of the microscopical exhibit.

Dr. Dall, curator, and Dr. Stearns, adjunct curator, of the Department of Mollusks, U. S. National Museum, both gave attention to the selection of a collection of mollusks representing the most important commercial species.

Prof. Gilbert and Dr. Henshall accompanied the expeditions sent out to collect live fish near Cincinnati, and both entered heartily into the work. Their knowledge of the waters and fauna of the region was of much assistance.

Dr. Bartlett, who had his headquarters at Quincy, Ill., where Mr. Moore spent some time in collecting fish, rendered material aid to the agents of the Commission.

INDEX TO APPENDICES.

1. FISHERIES OF THE PACIFIC COAST.

1. FISHERIES OF THE PACIFIC COAST—Continued

1. FISHERIES OF THE PACIFIC COAST—Continued.

1. FISHERIES OF THE PACIFIC COAST—Continued.

1. FISHERIES OF THE PACIFIC COAST—Continued.

1. FISHERIES OF THE PACIFIC COAST—Continued.

1. FISHERIES OF THE PACIFIC COAST—Continued.

2. STATISTICAL REVIEW OF THE COAST FISHERIES.

2. STATISTICAL REVIEW OF THE COAST FISHERIES—Continued.

3. DISTRIBUTION OF FISH AND EGGS.

3. DISTRIBUTION OF FISH AND EGGS—Continued.

4. ALBATROSS EXPLORATIONS.

4. ALBATROSS EXPLORATIONS—Continued.

LABORATORY AT WOOD'S HOLL.

6. ENTOZOA OF MARINE FISHES.

7. PARASITE OF THE TIGER SHARK.

8. THE CENTRARCHIDÆ, OR FRESH-WATER SUNFISHES.

9. APODAL FISHES, OR EELS.

9. APODAL FISHES, OR EELS—Continued.

9. APODAL FISHES, OR EELS—Continued.

10. CHEMICAL COMPOSITION OF FOOD-FISHES.

10. CHEMICAL COMPOSITION OF FOOD-FISHES—Continued.

10. CHEMICAL COMPOSITION OF FOOD-FISHES—Continued.

CHEMICAL COMPOSITION OF FOOD-FISHES—Continued.

11. CENTENNIAL EXPOSITION AT CINCINNATI.